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CONTENTS.

EDITORIAL:
Wireless Telegraphy ... 533
Coal or Water? ... 533
Central Station Fires ... 534
The Remuneration of the Engineer ... 534
Telephone Engineering—I, by J. C. Kelsey ... 536
The Hydroelectric Station of Champ ... 538
Electrification of the Liverpool and Southport Railway, England ... 542
Around the Intra-Mural ... 546
Wireless News Service Across the Yellow Sea ... 547
Electrical Notes from India ... 547
Rubber Insulation ... 548
A Test for Induction Motor Windings, by G. H. Garcelon ... 549
Does Not Like the Electric Light ... 552
The Berlin Teletyping Central Station, by Dr. Alfred Gradenwitz ... 553
The Rated Speed of Electric Motors as Affecting the Type to Be Employed, by H. M. Hobart ... 555
Contribution to the Discussion on High-Tension Transmission ... 558
The *Engineering Press Monthly Index Review* ... 559
Electrical Notes from Europe ... 560
Electrical Patents ... 562
Lehigh University Register ... 563
The American School of Correspondence at the Armour Institute of Technology, Chicago, Ill. ... 563
News from Mexico ... 564
Complete Combustion of Coal ... 564
The International Electrical Congress ... 565
Electric Tramways and Railways in Nice, France ... 565
British Street Railways ... 565
Developments in Petroleum During 1902 ... 566
Street Railway Statistics ... 566
The Faraday Society ... 566
Production of Mica in 1902 ... 567
A Steam Turbine with Isothermal Expansion ... 567
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE ... 568
More Properties of N-Rays ... 569
Electrical Methods of Measuring Temperatures ... 569
INDUSTRIAL SECTION:
New Railway Telephones ... 570
A Summer School for Artisans ... 570
A High-Tension Strain Insulator ... 571
An Electrically Equipped Parlor Car ... 571
Small Single-Phase Motors ... 572
Incandescent Lamp Manufacturers and the Patent Situation ... 572
Transformer Primary Cutout ... 573
A New Type of Sign Flasher ... 573
The Keeler Water-Tube Boiler ... 574
The Thomas S. Clarkson Memorial School of Technology ... 574
Isolated Storage Battery Installation ... 574
CURRENT ELECTRICAL NEWS ... 575

WIRELESS TELEGRAPHY.

Wireless telegraphy seems to be rendering good service in the Russo-Japanese War—at least, for the purpose of transmitting news. The London *Times* has a despatch boat fitted up for this purpose, by means of which messages are sent to Wei-Hai-Wei, and thence transmitted over the British cable. The *Times* recently published a message 1,400 words in length, which had been sent in this way. This is probably the longest message that has ever been sent by wireless telegraphy, and seems to indicate that the installation is working most satisfactorily. The equipment on the boat has a capacity of from twenty to thirty words per minute, and the range is probably at least 100 miles, and greater under favorable conditions. Messages sent over this route have the advantage of not passing through the hands of either the Japanese or Russian censors, and therefore can be depended upon to contain all the news that the correspondent may be able to gather.

COAL OR WATER?

A bill granting authority to a certain company to utilize part of the water of Niagara Falls, now before the New York state legislature, suggests certain phases of development of our waterfalls not sufficiently considered. All will admit the grandeur of Niagara Falls, and no one will deny that it is a valuable asset to the country; but will the greatest good to the greatest number be done by preserving this cataract merely for scenic purposes, or by taking full advantage of this valuable resource? It is true that, in its present state, Niagara Falls brings large sums of money into the state, but it only does this by drawing money from other states. The falls as an attraction for visitors is not an actual producer of wealth. Visitors get some return for their money, but the permanent value of this may be questioned. Does a man become a better man for the rest of his life because he has seen this magnificent spectacle? On the other hand, if developed for power purposes, Niagara Falls will become—in fact, is now becoming—one of the most important agents in promoting our welfare and adding to the wealth of the country.

Waste of Coal.

Another phase of this problem relates to the enormous use of coal for power purposes. We are burning our coal extravagantly, without thought of the future. Our methods are little more than barbarous. For instance, we use electric lights lavishly, without stopping to consider that only a fraction of one per cent of the energy of our coal is actually turned into useful light; and every pound of coal burned subtracts just that much from the resources of the country. Coal, once used, is gone forever, while a water power is inexhaustible, if properly protected.

Difference between Use of Coal and Use of Water.

The point of view usually taken to-day does not seem to be right. It is generally cheaper for us to use coal than to develop water power, because the coal costs only what it takes to get it out of the mine. Should we not think more of the future, and remember that some day the mines will be exhausted, and our most widely used source of power at an end? What would be thought of an explorer who lived upon his slender stock of concentrated foods, because this method was simpler and less trouble than to hunt for game? Yet will not a somewhat similar position face, possibly not ourselves, but our descendants? On the other hand, a water power, once developed, is a permanent investment. Its use does not decrease the resources of the country, for, if it were not used, its power would simply go to waste.

Develop Water Powers and Save the Coal.

As regards Niagara Falls, or any other of our large cataracts, while it would be a calamity to turn aside all the water and

leave them dry, this loss would be nothing compared with the giving out of coal. Every effort should be made to conserve our coal supplies as much as possible. Some satisfactory adjustment of the question of utilizing water powers will be made, and the sooner this can be done the better it will be for all. The development of a water power should, in all cases, be encouraged, provided, of course, the rights of the people are protected.

CENTRAL STATION FIRES.

In the recent discussion of the fire risk of transformers, methods of reducing the risk were considered from various points of view, but nothing was said about the proper means to be adopted for extinguishing a fire with the least possible damage to the machinery. This is a subject of much importance, because prompt measures are necessary to prevent a fire from spreading; but the men in charge may, in their haste, adopt means for putting it out which, in themselves, may cause unnecessary interference with the operation of the station. Indeed, it may sometimes be advisable to let an arc burn itself out, if there is practically no danger of the fire spreading to other parts, and when an attempt to put it out would endanger neighboring devices.

Methods for Extinguishing an Arc.

An electric arc, started by the failure of any apparatus, or by any other means, does not require air to maintain it; it will continue to burn as long as the metals between which it passes last. It can not be smothered by simply shutting off the supply of air, though this action, of course, may prevent the fire from spreading to other material. Turning a stream of water on the arc would, in most cases, put it out, but would probably start trouble at numerous other points, and might possibly disable the entire station, or part of it, for several days. An arc may be extinguished by any means which will break up the column of hot vapors which forms the conducting medium. A bucket of earth or sand, thrown directly upon the arc, will usually put it out without interfering with the operation of the station. Frequently a broom, if used vigorously, will accomplish the same purpose.

Fire Department Should Have Definite Plan for Fighting Electric Fires.

Every electric station should have a well-understood system of fighting fires at their beginning. The first few moments may decide the fate of the station, and although an alarm should be sent in whenever there is any danger, every effort should be exerted to extinguish the fire before the fire department reaches the scene. A brilliant arc, accompanied by dense volumes of smoke from burning rubber, may lead the fire department to believe that the trouble is far worse than is really the case, and a flooded dynamo room will generally cause a more or less protracted shutdown. It would be a good idea, also, if the fire department could have some definite plan of fighting the fires in electric stations. A little good judgment at the beginning will save much property and inconvenience.

THE REMUNERATION OF THE ENGINEER.

From time to time the question of the remuneration of engineers as compared with that of other professional men has been discussed both in the technical journals and by the various engineering and scientific associations. It is, however, always a timely topic and will be, until the absurd conditions which now exist give way to a new order of things in which the engineer will be accorded his proper status and paid commensurately.

The Requirements for Professional Work.

The best engineers to-day do not earn—in their professional work—one-half as much as lawyers or doctors with the same standing in their own lines, in spite of the fact that it requires the same breadth of mind, the same order of intelligence, a longer and more arduous preparation, and more continuous study during all the years of professional practice, to make a good engineer, as compared with his more favored learned brethren.

Compare also the requirements in the cases of the three professions.

The lawyer has but little exact knowledge. The law itself is in many cases not clearly defined. Every case is handled on the basis of argument, and if lost why the judge or jury is at fault—the pleader has done his work masterfully, but the ways of the judicial mind being devious have gone in an adverse direction. Corporation law, while voluminous as to quantity, is easily acquired. Let those who know both compare it to learning electrochemistry or the subject of alternating currents. The engineer reports on an electric railway, and his opinion as to costs, operation, traffic and dividends is based on extended investigations, tedious computations and careful weighing of a multiplicity of data. On his recommendation—without which the road would never be built—the shareholders invest, but first call in a lawyer to "organize" the corporation. His work is merely to follow the general outline of forms, and offer shrewd advice as to liabilities, how to raise values and still keep within the law, and other helpful suggestions which have been reduced to an easily remembered formula—and he will get as much for his services as will the engineer for his patient, painstaking work, produced at the expense of mental effort and using as the tools of his work more difficult formulæ than those for which the lawyer is paid. If the road goes to everlasting smash, the lawyer is well out of the way of the flying debris, and the trajectory of no hurtling fragment leads to him, but the poor engineer who said it would pay is buried underneath the ruin without having the satisfaction, like Sampson of biblical memory, of pulling down the temple himself. This, in all probability, has been done by the management of the road. The engineer adds to the wealth of the world; the lawyer transfers it after the earning in such directions as seem individually most profitable, but not to the behoof of the general public.

The Lawyer and the Electrical Engineer.

One week a lawyer may appear in court in behalf of some party or corporation, and logically prove to the jury that

said client is high-toned, honest of purpose and greviously assailed by this suit. The following week the same lawyer may appear in a case against the same client and prove—also logically—that same said party or corporation is morally, legally and everlastingly rotten. It is good law and nobody considers it wrong or ground for hard feelings. The engineer who makes an affidavit or report in favor of a device, system or process can never, so long as he lives, even change or revise his statements—much less reverse them—no matter how his interests may change. And for this, that an engineer ties himself for life to one position and because of it must sometimes place himself at the mercy of one corporation, he must demand a proper recompense.

The Physician and the Electrical Engineer.

And the doctor; he, too, outdistances the engineer for all that the latter has steam and electricity to aid him. An operation by a skilled surgeon, requiring two hours' time, a dollar and a quarter's worth of ether and a kit of carving tools, costs five hundred dollars. For what? Why, for "knowing how," not for the time. And the engineer, who also "knows how" and is now suing to get payment of a bill for three hundred dollars, representing a week's work—the "know how" accompanying the services much as does a chromo with a pound of tea—smooths his weary brow and wrinkles it again in wonder and in admiration of the medical genius. True it is that the patient often succumbs after a surpassingly skilful operation, backed by supernatural sagacity, but, brethren, the ways of Providence are past finding out, and if the call comes, who can stay the spirit that hearkens? Surely no one can blame the doctor. But the unlucky engineer, who had a whole week's work at fifty dollars per day, will be held responsible for all time to come if there is a hitch in the operation of his plant, or if his bridge falls through or his dam gives way.

The Reasons for the Lack of Appreciation.

These facts being unhappily true, the question arises as to their cause. Several reasons may be adduced, the most important being:

First—The profession is a new one, and has not yet made its impress on the professional world, even though it has changed the surface of the habitable globe.

Second—The people generally look on an engineer as a high-grade mechanic of superior experience; not as a broad-minded professional adviser. This condition is nurtured by our loose nomenclature, an engineer in the English tongue meaning variously a runner of a three-horse-power stationary engine who also in moments of leisure adds a sufficiency of fuel to the boiler to keep up steam—the unions permitting—or a driver of a locomotive; or a land surveyor, who can handle a compass but thinks a theodolite a foolish contrivance; or an armature winder; or an erector of machinery; or finally a real engineer who is a technical graduate, a student later, and who can and does produce results that add wealth to the world and mitigate the curse of Adam. With these to choose from, it is scarcely to be wondered at that the public is sometimes a little mixed as to the mental attainments of a man who is described as "an engineer."

Third—The general public has not yet learned to make use of the professional services of the engineer. Usually a technical adviser is only retained when the work to be done is of comparatively great importance. A lawyer will give a few minutes' advice for say ten dollars, a doctor will look at your tongue if you are "out of sorts" and write a prescription while he steps into his buggy for five dollars, but the man who goes both to lawyer and doctor will not go to an engineer and talk over a small matter at a cost of ten dollars. This is an important feature. No man who undertakes any technical work whatever—whether it be warming his billiard room or putting a new jack-shaft in the power station—should do it without the short five or ten-dollar consultation with an engineer.

Fourth—The incompetents—there are many, so many incompetents in the engineering profession, for there is no examination required to enter it as there is in law or medicine. A mechanic reads a few simple works, buys an indicator, a voltmeter and a pack of cards with "electrical" or "mechanical engineer" printed on them, and the work he does will cause his employer to do his own engineering or trust the manufacturing companies for advice, and five dollars a day is this "engineer's" charge for services.

The Influence of the Non-Technical Practical Man.

Then there is the man who worked several years in a power station and knows all about it—practically. The "practical" man catches many fine fish with golden scales. This magic word "practical" differentiates him at once from the kid glove theorizer. He can do the things the collegian merely thinks about. He charges six dollars a day for his services and is of the opinion that in Germany the amperes are larger and hotter than in this country, but the volts are not so satisfactory.

And the hard-working, plodding chap who has studied hard, got his degree and really knows a lot, but has no originality, no breadth of vision and was simply cut out for a storekeeper or something in which sterling qualities coupled to an unscientific mentality bring success. As he doesn't get along very swimmingly, why ten dollars a day is his figure—hoping by a low price to catch a bit of the business that is ever going past him. Truly, an engineer, like a poet or painter, is born, and all the technical schools in christendom and heathendom, too, can not make one.

There are others that go to make up the list, but these types are the most prominent.

The Remedy for This State of Affairs.

This condition can only be remedied by bringing the public to recognize the value of engineering services. It must be taught how the engineer earns his fee and it must realize that he has learned his profession by dint of long study and hard work. The ability to give a valuable opinion in a few words has been acquired in the hard school of experience. This education of the public can not be accomplished unless engineers charge adequate fees. Engineering services will not be valued above the price paid for them, and nothing less than the accustomed fee should be accepted. Every engineer should stand upon his dignity if the proper position of the profession is to be recognized.

TELEPHONE ENGINEERING—I.

BY J. C. KELSEY.

SERIES GROUNDED SYSTEM.

The object of this article, and of those following, is not to force upon the reader an endless and indiscriminate collection of telephone circuits, but to show only those that have played a prominent part in the development of the telephonic art, and have at one time been a standard form. While circuit design is but a small part of telephone engineering, yet it is important, particularly to the beginner, as a foundation upon which to build his knowledge. To begin the study of one of the late circuit arrangements without any knowledge of the reasons for such a combination and its usage would throw the student into hopeless confusion. It is for this reason that it is advisable to begin in the simplest era of telephonic practice, and trace the conditions that have caused the several changes in the practice.

The first system put into wide practical usage, having a bearing upon the present practice, was the series grounded system. It is not meant that this system is obsolete by any means, because it is safe to say that over one-third of the present-day telephone service is given over series grounded circuits.

This system is the simplest of all. One wire ran from the exchange to the subscriber, using the earth as a return. One wire virtually went through the switchboard jacks, and terminated in a low-resistance drop of large size. I mention the size of the drop to bring out the point that one of the great ideals of the designing engineer is a reduction of the size of the drop and jack, or signal and jack spacing, so that floor space will not be a prohibitive feature. The immense drops and jacks go to show that the original service requirements that this system was designed to meet were not great. The subscribers were few in number, and the telephone did not find such wholesale usage as at the present day. The pole lines would take care of double the number of subscribers that the metallic line requires, and was free from complications of transportation. Certainly the owners of the grounded systems were not anxious to adopt the metallic system, and this fact is borne out that these systems made a futile fight against the earth currents of the street railway, and, in spite of this, hung on to this absolutely inadequate system until the common battery systems became available.

After the street railway systems found that they had a legal right to use the earth (the telephone interests actually contested it) the ultimate abandonment of the series grounded system was assured. To secure relief from the noises due to earth currents, the common return was resorted to. It did not free the lines from cross-talk and inductive disturbances, however. And if the subscriber's line was not helped by a common return it was changed to metallic service—if the subscriber paid for it. But to give metallic service to a subscriber with a switchboard that is limited to a grounded service was the next problem. To make a satisfactory connection between a metallic line and a grounded line the balance must be preserved. The repeating coil was the means whereby this was accomplished, and the discovery of the usefulness of this device also made it possible for any grounded subscriber to have toll connection. Prior to this he was compelled to go to the exchange office to get the metallic long-distance service. This makeshift, owing to the great number of metallic lines, literally caused exchange rooms to be lined with unsightly repeating coils which collected dirt in a very liberal manner, as was ever evidenced upon the removal of old apparatus to make way for the new.

The instrument shown in Fig. 1 is the same as the series instrument of the present day. No advance has been made along this line. The hook switch separates the talking and ringing functions. When the receiver is on the hook, the instrument is in a condition to receive a call or send one. When the receiver is off the hook, the circuit is closed through the transmitter, primary coil and battery, and the instrument is in a condition for speech transmission. With the receiver off the hook, no call can be sent or received. If the generator and ringer were left in the circuit during transmission, the talking currents would be weakened. If the talking circuit were left in, the batteries would be run down and the ringing current weakened. The eighty-ohm series bell is not a sensitive piece of apparatus anyway. That fact caused the generator to be normally short-circuited, in order to prevent the inductance of the armature weakening the incoming generator current to such an extent that the bell will not ring. However, when the generator handle is turned the short-circuit is removed, and the bell and line get the full force of the current.

At the exchange office, the line ends in a jack and a drop or signal, the earth or common return completing the circuit. The jack is a cut-off device, for the purpose of disassociating the signal from the line when a plug is inserted for a connection. There are several reasons for this, one being that the only function of the line signal is to attract the attention of the operator. When that is accomplished, it has no further usage. Another reason is that an eighty-ohm drop bridged across the talking circuit would seriously interfere with good transmission. And there is a good reason from the operating standpoint, for if the drop were not cut off, the drop would fall every time the subscriber was signaled. If the board was a small one, the only evil effect would be to cause the operator unnecessary time and labor in restoring the drop. But if the board had 1,000 lines, for instance, and, according to Fig. 1, there were five multiple jacks and one answering jack for each line, an operator ringing in the multiple would not only ring the subscriber, but would throw down the line drop in front of the regular answering operator. The operator would in the ordinary performance of her duty plug into the jack of the line calling, to answer, only to find herself breaking into a conversation.

A multiple-jack system is one which gives the operator the facility of connecting the group of lines in her control directly with every subscriber in the office. Ordinarily, each operator may be said to handle 100 lines. If the office did not exceed 100 lines, one answering jack and drop sufficed. If the number increased to 200 lines, still one jack sufficed, as each operator could reach the jacks on the others' lines. If the number increased to 400 lines, and four operators were required, they could not reach all the others' lines, so the jacks of the first 200 lines were multipled to the third and fourth operators, and *vice versa*. The number of subscribers growing to 1,000 lines, five sections or ten operators' positions would be necessary, and each line would have five multiple jacks, J1, J2, J3, J4, J5, and answering jack J6, as shown in Fig. 1. As it is necessary to cut off the line signal, the jacks are arranged in series. The arrangement is more properly known as a series-multiple jack, and is open to the objection of having movable contacts in the path of the talking circuit. A 1,000-line board, with five sections, two operators to a section, will have 5,000 multiple jacks and 1,000 answering jacks, or a total of 6,000. Compare this with a 2,000-line board, with twenty operators' positions and ten sections. There would be 20,000

multiple jacks and 2,000 answering jacks, a total of 22,000. It is seen that as the exchange increases in size, the number of multiple jacks per line increases, making the cost of a larger board per unit somewhat greater than a small board.

When the subscriber calls for the operator, he turns the generator handle on the instrument, causing an alternating current to pass over the line through drop D. This current passes through the succession of multiple jacks, through the winding of D, causing the shutter to fall. The operator inserts a plug into the jack, which mechanically cuts off D. She presses key K3, and places her operating set in connection with the subscriber's instrument, through the spring contact of J6, plug P, closed contact of ringing key, K1, through one-half of the eighty-ohm winding of the clearing outdrop COD, and the

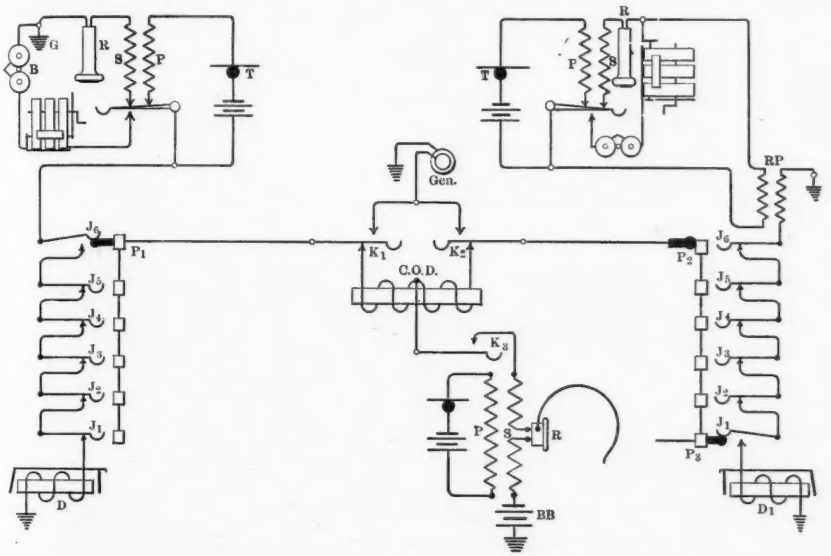


FIG. 1.—COMBINATIONS OF THE SERIES GROUNDED SYSTEM.

earth or common return. Learning the number desired, the operator would insert calling plug P2 into the jack, and ring the party with key K2, were it not for a very necessary precaution. One of the necessary rules of operating is that under no circumstances is a connection to be forced upon people already in conversation. Now how is this operator to know that the line is busy. She can not see the jacks along the board, besides it would take too much time to look for them. She therefore must have some means whereby she may quickly learn the condition of the line without interfering with the parties talking. That means must be either audible or visual. The audible test is preferable, and a busy indication is conveyed to the operator by clicks in the receiver upon the alternate touching of a busy jack. If she receives no click, she is at liberty to plug in and ring on the line.

Of equal importance to the necessity of cutting off the line signal during connection, is the protection of that connection during its usage. The busy test and the method of operating the cut-off relay we will find to be the vital considerations of every system to be studied. To accomplish this busy test, each jack is arranged with the body of the jack insulated from the spring of the jack. The plug must be firmly held, and the thimble of the jack accomplishes that result. It is represented in Fig. 1 by small rectangles at the end of each spring. The series of thimbles is connected together in multiple, and insulated from the series of talking spring contacts. To accomplish a test, it is necessary that the potential of the jack be changed by the entrance of the plug. Normally, the thimbles have no potential. To produce a change, the plug in this system was made of solid metal, so that when it was inserted it short-circuited the spring of the jack and the thimble. As the system was a grounded one, the entrance of the plug caused the thimbles to have earth potential. To conform the cord circuit to this condition, so that the operator's receiver would detect that difference in the jack thimbles, a battery BB was placed, as shown in Fig. 1, between the secondary winding of the induction coil and receiver and the earth. The battery BB was composed of several cells, about six volts, and it gave a potential to all the plugs, above that of ground, all the time the listening key K3 was closed. To touch the plug at six volts potential to the thimble of an unplugged multiple of jacks gave no sound. To touch a plugged-up jack thimble multiple gave a click to the receiver, and gave warning of usage.

This test system was not satisfactory, in the light of recent practice. When the plug was inserted into the jack, the ground put on the thimbles was the subscriber's ground. Making a test on a busy talking subscriber would give the subscriber the same testing clicks that the operator receives. That would be particularly objectionable on a very busy line. Then as the street railway earth currents began to manifest themselves, differences of potential between earth points became apparent. A subscriber residing along the street railway tracks had his line in the direct return path of the earth currents. It would make the line noisy, and his service annoyed by a false busy test. That is to say, the insertion of an operator's plug would put the jack thimbles at the potential of the subscriber's ground. That ground might have a potential of six volts with respect to the exchange ground. The operator, in making a test with her six-volt busy battery, might not hear the test clicks loud enough to refrain from breaking in on the conversation, ringing in a talking subscriber's ear, and putting a third party on connection. The common return usually alleviated this trouble. But the feature of clicking in the talking parties' ear was very objectionable, and has led to a most careful avoidance of this feature in the late systems.

When grounded service became too objectionable, the subscriber was given metallic service from his instrument to the exchange office, but not quite to the switchboard. To accomplish this, a repeating coil RP was placed in the line at the office, protected by the arresters. The metallic party, shown at right hand of Fig. 1, could not enter the board on a metallic basis, because the board was designed for single-wire service. The repeating coil connects grounded and metallic lines effectively, and enables the metallic party to enter the grounded board consistently. This method made the subscriber's line quiet, but did not ensure quiet connection with grounded lines. If the grounded line was noisy, the metallic subscriber heard it, too. Naturally, the system passed quickly out of date upon the advent of the trolley, and particularly since the public insists upon a rapid, consistent service.

Assuming that No. 50 calls No. 650, No. 50 turns magneto handle, throws down drop D, operator plugs in, cuts off D, throws listening key K3, ascertains the wishes of No. 50. No. 50 calls for No. 650, operator tests with plug P2, and hears no receiver click. She inserts plug P2 into multiple of No. 650, cutting off line signal D1. She throws ringing key K2, ringing bell of No. 650. If No. 50 has hung up in the meantime, she rings back with key K1. When No. 50 rings off, the current passes through the series drop COD, and the bell of No. 650, or *vice versa*. The operator challenges the line, and if No. 50 or No. 650 do not want another party, she pulls down the connection.

The Hydroelectric Station of Champ.

An Interesting Industrial Power Station in the Province of Isère, Erected and Operated by Local Interests.

By Enrico Bignami.

THIS installation is particularly interesting because of the characteristics of the hydraulic and the electric par s, and because there has been created about it an industrial syndicate which furnishes a remarkable example of the socialization—in the proper sense of the word—of waterfalls.

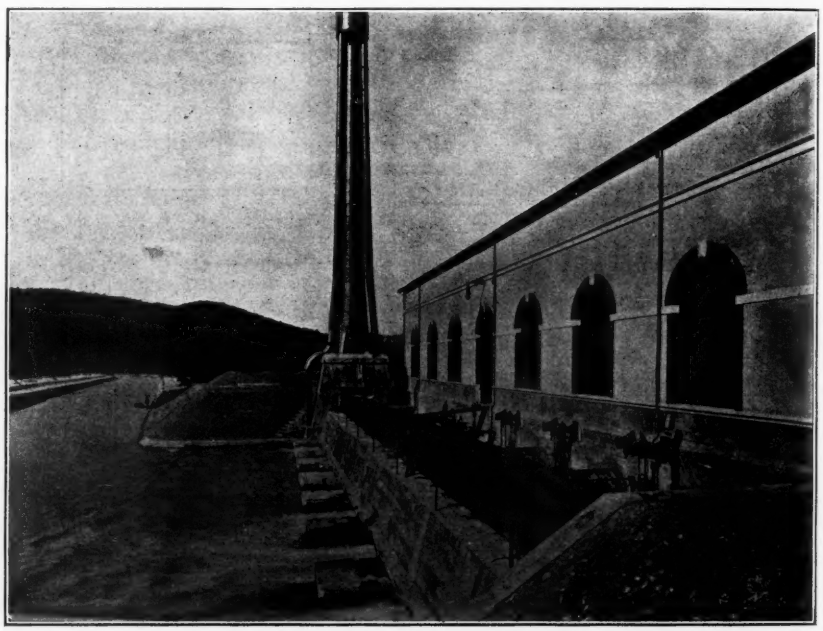
The Champ station is intended to furnish electrical energy for motive power to the diverse industries installed principally in the valleys of the Fure and the Morge rivers—small water-courses which flow into the Isère a score of kilometres below Grenoble; hence the name, La Société Hydroelectrique de Fure et Morge, given to the company which has exploited and constructed this station. This company has not made any lighting installations, as the districts traversed by its lines are already supplied by other enterprises for distributing electrical energy.

The part of the course of the Drac on which the fall which supplies the Champ station has been created is that which just precedes its confluence with its principal affluent at St. Georges de Commiers. Starting from that point, the bed of the Drac which has, up to this point, been confined in deep, narrow gorges, spreads out over a large plain formed by its detritus. During floods, when the flow of the river attains possibly 1,200 cubic metres of water, the breadth of the surface covered by it exceeds one kilometre. Under ordinary conditions the flow is only sixty to eighty cubic metres, and only a very small part of that surface is occupied by the bed of the torrent; a bed which is frequently changing its position in the alluvium of which it is formed.

Under these conditions, a fall could be created neither by means of a retaining dam nor by a canal following the side of the stream. The solution adopted consists in drawing off the water of the Drac by a submersible dam of low height, in a large canal placed in the plain formed by the torrent—that is to say, in its larger bed. The height of the flow utilized—by which is meant the difference between the level of the water in the intake chamber and that in the tail-race—is from thirty-seven to forty metres. The flow obtained is seventeen cubic metres per second. Allowing for all the different losses due to the passage of the water in the screens, pipes, etc., the useful fall is reduced to thirty-two metres, which gives 7,200 horse-power. The intake for the water is formed of a fixed dam and a movable dam, and a receiving basin equipped with gates. After passing this basin, the water flows into a large settling chamber, from which runs a canal 600 metres long, terminating in the basin where the pipe line starts.

The stationary part of the dam is formed from a wall of concrete 130 metres long, twelve metres broad at the base, and varying in height from two to five metres, according to the profile of the bed of the Drac. The movable section of the dam is composed of two gates eight metres long and one and one-half metres high, operated from an iron foot-bridge. The movable dam serves to maintain the current of water through the collecting basin, so as to avoid deposits of gravel before the screens. The bed of the movable dam rests on a metal caisson, seventeen metres by six metres, sunk ten metres below the stationary dam by means of compressed air. To avoid erosion by the action of gravel, the bed of the dam, which is formed by the upper part of the caisson, is covered with a shield of oak beams fourteen centimetres thick.

The wall of the collecting basin is pierced by openings for taking in the water, and is built of concrete. It is eighty metres long, pierced at fifteen points, each opening being two metres broad and one and one-half metres high. These can be closed by gates. A screen of special form is placed the whole length of the wall, on the side toward the Drac. It is formed of plates of iron disposed like a shutter, so that pebbles moving along the plates are caught by the current produced by the opening of the movable dam, and can not enter the canal. After passing the intake basin, the water arrives at a sort of opening out of the canal, which forms the first settling chamber, and has a surface of 2,500 square metres. It has a weir and gates which allow it to be emptied, carrying out the material deposited by the water. The canal, which starts at the settling basin, is 600 metres long, and has a width varying from sixty metres to twenty-two metres, with a depth increasing from one and one-half metres to four metres. The canal is constructed partly in excavation and partly by an embankment. Its sides are covered with a revetment of hydraulic concrete. The slope of the bottom is four millimetres per metre.



THE POWER-HOUSE, CANAL AND FOREBAY OF THE HYDROELECTRIC PLANT AT CHAMP, FRANCE.

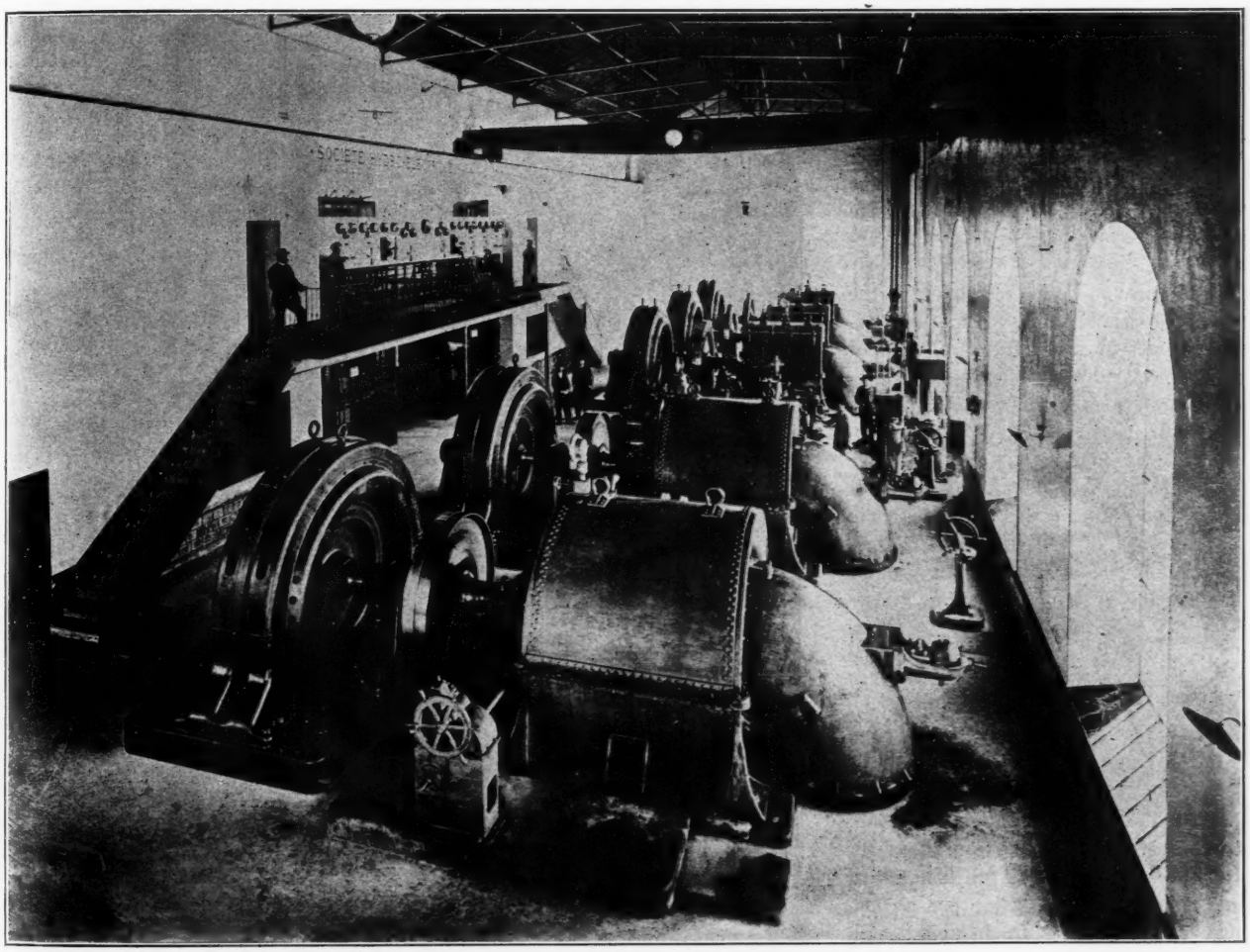
The water basin, which serves as a terminus for the canal and from which the pipe starts, is built of concrete. It has a total surface of 900 square metres and a depth of four metres. This basin is divided into two compartments by a wall 1.2 metres high, surmounted by a screen. The first compartment receives directly the

water from the canal, and is intended to check the current and to catch material entrained by the water. The second compartment of this basin has a depth varying from four to seven metres, and from it starts the concrete tube which forms the first section of the pressure canal.

The pipe is 3.3 metres in diameter, with a slope of seven millimetres per metre and 4,600 metres long, of this 2,100 metres are formed of reenforced concrete, and 2,500 metres of sheet steel. The section of the pipe formed of reenforced concrete is designed to support a maximum pressure of a twenty-metre head of water. This is the most important pipe of this type which has yet been constructed. It is formed of a cradle of hydraulic concrete, in which rests the true pipe. The cradle is a half-cylinder, the extrados of which form a polygon with six irregular sides, and the intrados a half circle. This cradle was constructed in the ditch by means of wooden forms. The thickness of the pipe varies from 0.2 to 0.25 of a metre. Enclosed within the mass of concrete is a metallic core in the form of a network of iron rods. The directrices of this have diameters varying from eleven to twenty-two and one-half millimetres. The generatrices vary in diameter from six to twelve millimetres. The meshes of the trellis measure from ten to eleven centimetres.

The steel pipe, which starts where the concrete pipe ends, is formed of plates of soft steel varying in thickness from seven to fifteen millimetres. The sections are riveted together, and the pipe rests on a cradle of concrete half a metre thick, buried in the ground. This is thought to be the first time that a metallic pipe of large diameter has been laid in this way. This arrangement is advantageous as it prevents deformation of the pipe during the delicate operation of filling it, and has given excellent results. Further, the pipes are covered with a layer of earth and gravel fourteen centimetres thick, which prevents expansion and contraction due to changes in temperature. In this case these effects are not noticeable.

The mass of water in the whole length of pipe is 40,000 cubic metres, flowing with a velocity of two metres per second, so that it has been necessary to make provision for avoiding the water hammer in case of an abrupt stoppage at the station. To this end, three stand-pipes have been placed on the pipe line, two of reenforced concrete, and one of steel. The reenforced concrete stand-pipes are, respectively, nine and twenty metres high. The smaller is placed 400 metres from where the water enters the pipe. The larger is placed at the junction of the concrete and the steel pipes. The steel stand-pipe is thirty-five metres high, 3.3 metres in diameter at its base, and 1.4 metres at the summit. This is placed at the extremity of the pipe line, of which it is, in fact, the prolongation. It is connected to the pipe line by a round elbow. Its opening is 0.6 of a metre above the normal level of the operating room. This stand-pipe is surmounted by a reservoir also of sheet steel, three metres in diameter and two metres high, from which are carried three pipes each 0.6 of a metre in diameter. These descend at the exterior of the stand-pipe, and terminate in the tail-race, and are intended



View of the Interior of the Generator Room, Champ, France.

to carry off any water which may rise in the reservoir in consequence of a check of flow at the station.

The generating station is placed in the territory of Champ. It consists of a machine room, forty metres long and twelve metres wide, containing the turbines and the alternators. A traveling crane capable of raising a weight of fifteen tons has been installed here for facilitating repairs and handling the machines. In the basement, placed directly under the alternators, are the feeder galleries connecting the alternators to the switchboard. In front of the machine room, and also in the basement, is the transformer room, supplied with water under pressure for cooling this apparatus. A track running into this room allows the transformers to be carried easily to the repair shop, where there is a ten-ton traveling crane.

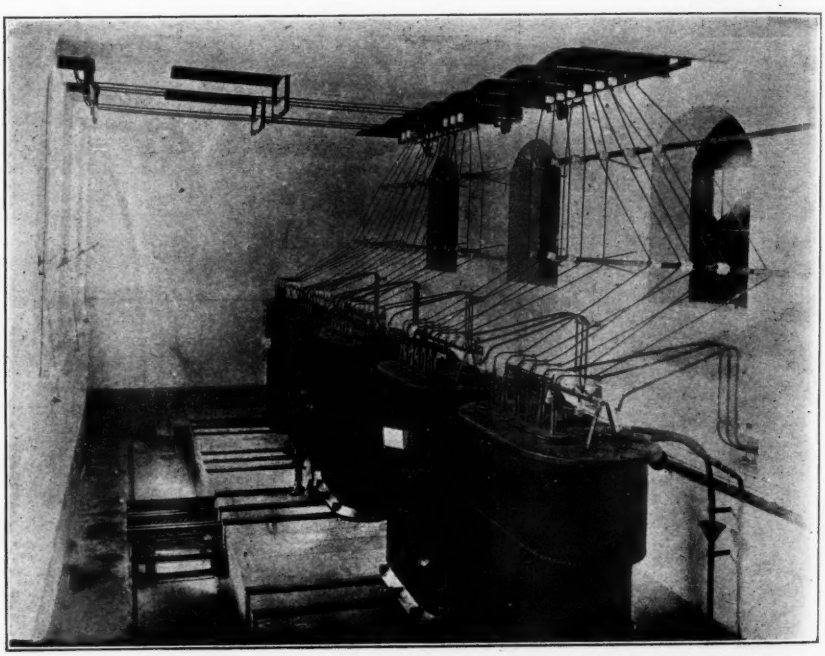
On the ground floor are found: in the centre, the switchboard and lightning arrester room; to the right, the office of the engineer, the telephone and storerooms, and, to the left, the engineer's living apartments.

The station contains, at this time, five groups of turbines and alternators, each rated at 1,350 horse-power. There are two exciter groups of 150 horse-power each, and a small five-horse-power turbine for supplying the hydraulic accumulators necessary for operating the turbine governors. The turbines are furnished by the house of Neyret-Brenier, Grenoble. They are of the centripiled type, with horizontal shafts, and a cylindrical distributing chamber. They operate with a draught of five metres, and they are attached to the alternators by flexible couplings. Their speed is 300 revolutions per minute, and they take, at full load, about four cubic metres of water per second. Three of the turbines are furnished with automatic regulators, and are supplied with compensating gates.

The electric equipment of the station was furnished by the house of Brown, Boveri & Company, of Baden, Switzerland. The alternators are of the three-phase type, with revolving fields. Each absorbs at its shaft 1,350 horse-power, when operating on full load, with a power-factor of 0.80. The generators give 3,000 volts at fifty cycles per second, and as the speed is 300 revolutions per minute, the fields have twenty poles.

The continuous-current dynamos, which serve as exciters, are two in number, and are rated at 150 horse-power each. The armature has a speed of 500 revolutions per minute. They are shunt machines, and generate current at 115 volts.

The transformers raise the voltage from 3,000 to 15,000 or 26,000 volts. These raising transformers, to the number of five, have an output of 1,150 kilovolt-amperes each. The cores are disposed in the same plane. The 3,000-volt primary windings are subdivided on each phase into three equal parts, placed in series. This provides for the possibility of changing the connections, for utilizing a voltage of 1,000 by grouping the three sections in parallel. The extremities of the secondary bobbins are attached to six terminals, placed on the transformer case, so that a simple movement at the high-tension switchboard will enable the connection of these coils to be made either in triangle or in star; the first giving 15,000 volts, and the second, 26,000 volts. The cores and windings are submerged in oil, cooled by water circulating in a double worm. The weight of each transformer is about 9,500 kilogrammes.

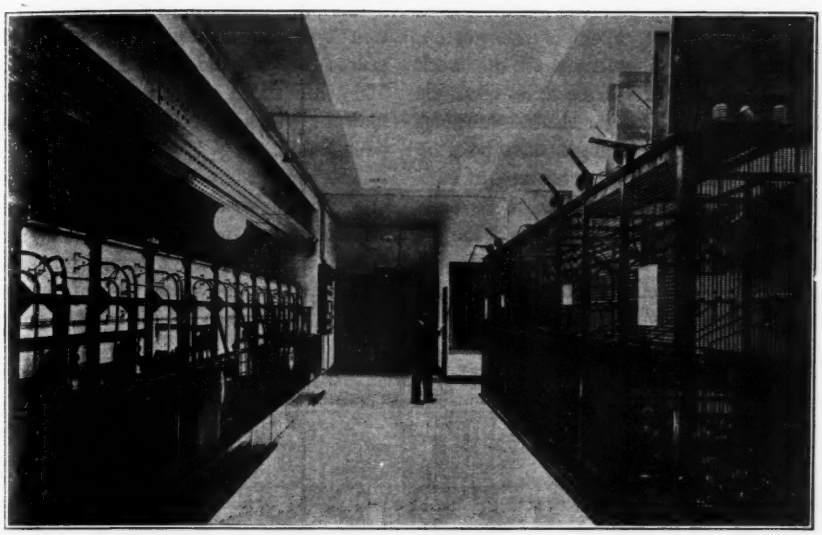


Interior of Room Containing the Step-Up Transformers, Hydroelectric Station at Champ, France.

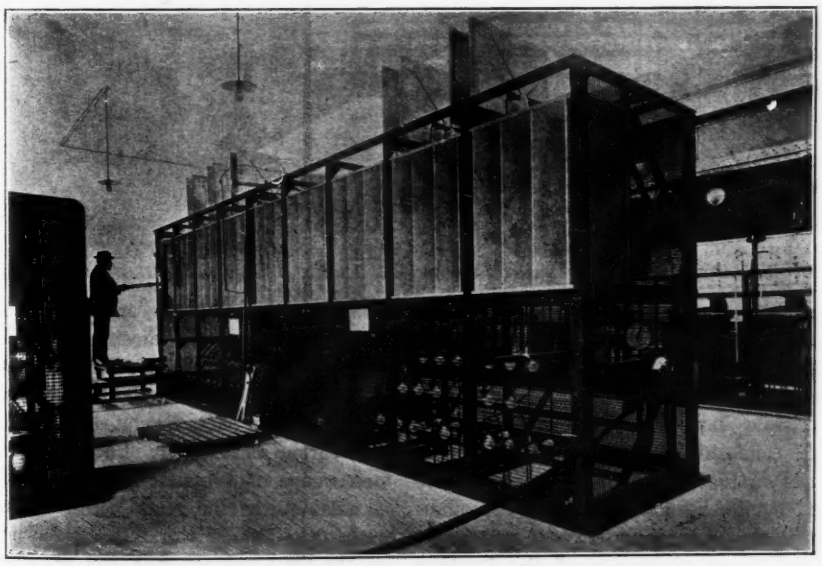
The distributing switchboards are remarkable for their simplicity. They include all measuring apparatus, as well as that for protection and for securing good operation of the station. They are three in number. The first is the mean-tension switchboard, placed on the ground floor between the machine room and the transformer room. The second is the low-tension switchboard, placed on the second floor, on the operating platform. The third is the high-tension switchboard, placed at the middle of the switchboard room, on the second floor. Back of the high-tension switchboard are placed the lightning arresters, of the Siemens horn type, with liquid resistance for protecting the apparatus in the station. At the exit from the station supplementary lightning arresters have been installed to increase the security. It has been the aim of the design to make the passage of lightning to the ground as direct as possible, with the object of protecting the station apparatus. The bases of machines, alternators, transformers, all frames supporting the electrical conductors—in a word, all metallic parts in the installation—have been grounded by means of two wires, each two millimetres in diameter, one connected to the water pipe, and the other to a shaft of copper sunk in the tail-race. The principal line of feeders is thirty kilometres long, and consists of six wires, each seven millimetres in diameter, supported by metal poles common to the Société Grenobles de Force et Lumière and of the Société Hydroelectrique de Fure et Morge. At Morians it divides into two primary lines, one composed of three wires, five millimetres in diameter, which runs to Voiron, along the valley of the Morge. The other, consisting of three wires, six millimetres in diameter, runs toward Rives. These primary lines are supported by wooden poles. The high-tension insulators are of moulded glass secured in America. They had been tested separately at 80,000 volts before being placed on the poles. The lightning arresters placed along the line are of the Siemens horn type, with liquid resistances. The overhead switches are of the horn type, similar to those placed on the

high-tension switchboard at the station. Current at 26,000 volts is distributed to the substations proper, to the number of eleven. These substations lower the voltage to 2,000 or 1,000, according to the locality. From these substations separate the secondary lines, which serve the stations of the subscribers. Certain industries use current directly at 2,000 volts, but the majority prefer to lower the voltage to 120 by means of transformers furnished by the company. All of the stations are constructed in the same way, a small kiosk of masonry three metres square, in general surmounted by a tower which serves for the entrance of the primary lines and the exit of the secondary. Before entering the tower, the primary lines terminate at an air switch; then pass to a set of lightning arresters of the horn type. The wires are then fixed to the terminals of a set of circuit-breakers similar to those of the generating station, and placed in niches of white marble. The secondary lines passing from the transformers are connected to a set of Wurtz lightning arresters; then to a set of circuit-breakers of the fusible type; mount the tower, and pass to the stations which they are called upon to serve.

The efficiency obtained for the installation is fifty-eight per cent of the hydraulic power, after a transmission of about fifty kilometres and a double transformation. This efficiency of fifty-eight per cent of an output of 7,200 horse-power gives 4,176 electrical horse-power available to the subscribers. Of this 4,176 horse-power, 3,300 horse-power has already been leased for a period of twenty years.



THE DISTRIBUTING SWITCHBOARD, HYDROELECTRIC STATION AT CHAMP, FRANCE.

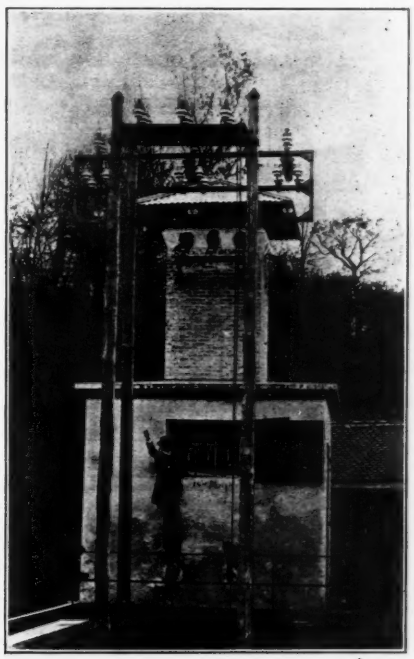


THE HIGH-TENSION DISTRIBUTING SWITCHBOARD, HYDROELECTRIC STATION AT CHAMP, FRANCE.

La Société Hydroelectrique de Fure et Morge has used a capital of 5,000,000 francs ($1,000,000) for this installation, so that the cost of supplying an electrical horse-power to the buildings of the subscribers is 1,200 francs. At the shaft of the turbines the cost per horse-power is about 550 francs.

The rates for power are 125 francs per horse-power-year for a twelve-hour day, and 150 francs for a twenty-four-hour day.

The cost of the installation has been covered by issuing stock to the amount of 3,000,000 francs, and by an issue of bonds for the remaining 2,000,000 francs. The members of the syndicate, which include the principal industrial companies of the valleys of the Fure and the Morge, had contracted for 3,000 horse-power even before the construction of the station. At the expiration of the twenty years fixed by the contract, the syndicate becomes the proprietor of the installation. With the 3,300 horse-power at present engaged, the annual income assured is 475,000 francs. This will be increased by 600,000 francs when all the power has been engaged, so that, in spite of the depreciation, in a period of thirty years the profit on the capital will have been about eight per cent. The power distributed to the houses serves for most diverse uses—tile works, paper mills, sawmills, printing-houses, weaving mills, silk mills, machine shops, coal mines, etc.



THE SUBSTATION AT RIVES, HYDROELECTRIC STATION AT CHAMP, FRANCE.

The installation has been operating for about a year with perfect regularity. Short-circuits caused by trees falling on the distrbuting lines have rendered necessary the stoppage of the entire station when it was producing 4,200 horse-power; but, in spite of the large quantity of water —40,000 tons, with a speed of seven kilometres an hour—no damage was done either to the steel pipe or to the concrete.

This successful utilization of a torrent which hitherto caused nothing but damage proves again that the region of the Alps includes riches which may be employed to increase the prosperity of the country and aid in its progress.

Electrification of the Liverpool and Southport Railway, England.

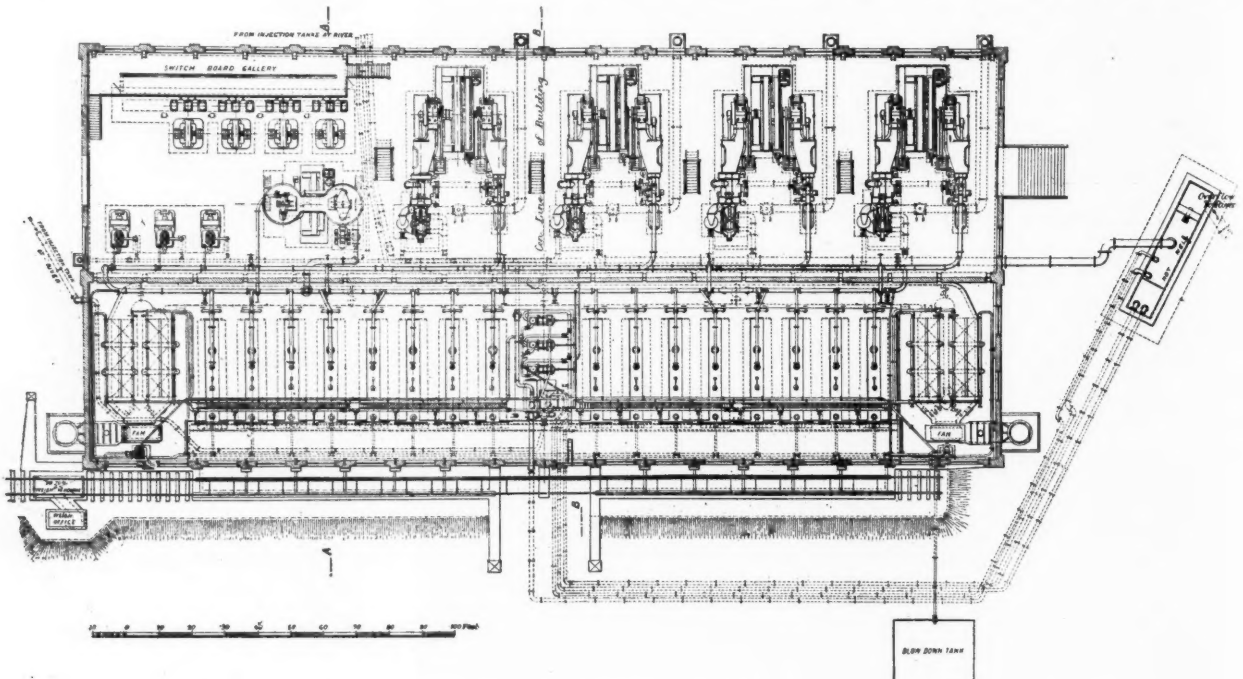
Electrification of the Lancashire & Yorkshire line between Liverpool and Southport, England, has just been completed. The district served is one suited for suburban residences, and, as previously operated by steam, it was impossible to increase the density of the train service, due to the shifting and switching required at the terminals. As this is practically all done away with in electrical operation, the train capacity of the road has been considerably increased. There are forty-seven miles of single track. Current is distributed and collected by means of a third and a fourth rail, the former being placed outside the track rails, and resting three inches above them. The fourth rail is placed between the track rails, and is slightly depressed. At all grade crossings—of which there are forty-six—the two conducting rails are interrupted.

The following description and illustrations have been abstracted from *Engineering* (London), March 18:

The order for electrification was entrusted to Messrs. Dick, Kerr & Company, Limited. Work was started on March 8 of last year and on December 29 last the first experimental electrical run was made over the line. It had been hoped to have the whole work completed by the beginning of this year, but the abnormal weather obstructed the work greatly, and it will still be some short time before the steam service is discontinued and replaced by the electric trains. Of these there will be fourteen, two out of this total constituting a reserve, twelve being sufficient to operate the whole service as at present proposed. Nevertheless, though the hope of completing the line by the end of last year was disappointed, the time actually taken is noteworthy, considering the magnitude of the work accomplished. Forty-seven miles of single track have been fitted for electric running, and included in this length have been no less than forty-six level crossings, at each of which special provision had to be made for interrupting the live rail and the return conductor. A power-house adapted for the development of about 12,000 indicated horse-power and a boiler-house designed for sixteen large Lancashire boilers have been erected, together with almost the whole of their equipments, and the substations at Sandhills, Seaforth and Birkdale have been completely finished and connected up with the high-tension leads on the one hand, and with the live rail by low-tension feeders on the other, while the new rolling-stock is practically complete, as twelve out of the fourteen electric trains provided for have been delivered, and the others are nearly ready.

The standard train will consist of two motor cars with two trailers placed between. The seating capacity of the train is 270, and the length overall is about 248 feet. The motor cars each weigh forty-four tons, the entire train weighing 140 tons. Each motor car is equipped with four 150-horse-power motors, two on each truck. The train is controlled by means of a double controller, there being two cylinders, one operating the motors of each car. This necessitates two main cables only running along with the train. These controllers are of the standard traction type, the shafts of the tube being geared together and rotated by one handle. They are fitted with a magnetic shield blowout which enables heavy currents to be handled.

The motors are of the four-pole type, and are constructed much on ordinary traction motor lines, but they are designed to take a considerable overload for a short time without an undue rise of temperature. They each weigh 6,050 pounds complete, the armature weighing 1,920 pounds, and the gear-wheels and housing 500 pounds. The coils are former-wound, and the commutators are built up of drop-forged copper bars, insulated with mica. The carbon brushes are provided with a wide range of adjustment, and provision is made for giving ready access to them and to the commutator. The gear-wheels on the axles are not split, but are forced on to an enlargement and keyed there. The running wheels are forty-two inches in diameter, which is unusually large for such service. The collector shoes are of steel and weigh ninety pounds each. They are hung from links secured to a wooden beam fixed to the bogie-frame, so that no current can pass up these links to the



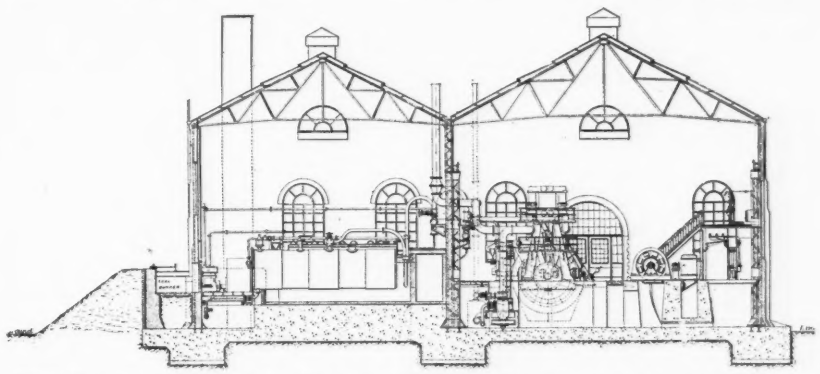
PLAN OF THE POWER STATION OF THE LIVERPOOL AND SOUTHPORT BRANCH OF THE LANCASHIRE & YORKSHIRE RAILWAY.

bogies, connection with the controller being made by means of a short length of extra flexible cable. A highly interesting feature of the equipments is constituted by the method of control, both sets of motors being entirely controlled from either end of the train at will. This is effected by two main cables only, the controller and resistances at the rear being entirely out of circuit when the train is being driven from the front end. Each car is therefore fitted with sufficient resistances to control the whole eight motors; and of these two sets of resistances, those on one car only are in use at one time. The train could, moreover, at any time be divided into two parts, and each part run independently. At starting, each group of four motors at each end of the train are run two in series and two in parallel, the whole four being placed in parallel when the train has got properly under way. The starting current momentarily reaches about 2,000 amperes during the period of acceleration, and falls to between 450 and 500 amperes when a speed of fifty miles an hour or so is attained. The resistances are fixed beneath the platforms of the cars, and are cast-iron grids, built up into a box form.

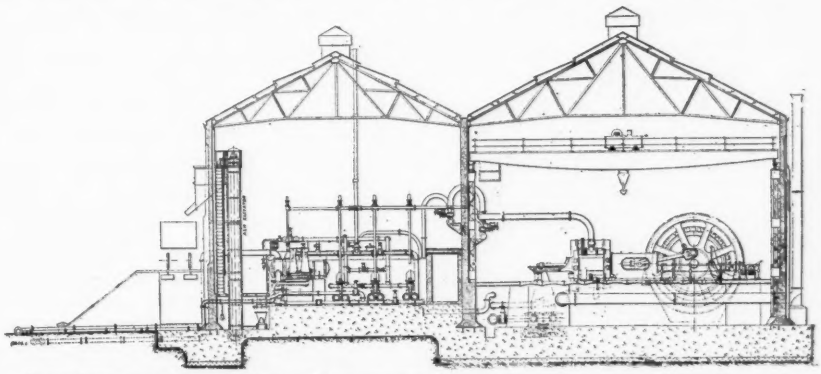
The controller combines in one practically two controllers of the makers' standard traction type, the shafts of the two being geared together and rotated by one and the same handle. The contact supports are hinged, so that access is readily gained to the interior. The controller is fitted with the makers' metallic shield blowout, which effectually prevents any arcing, in spite of the heavy currents transmitted. The reversing handle is also fitted to the frame of the controller, and by means of a special cable actuates the reverser provided for each of the eight motors.

The cars are vestibuled. There are four cable connections to be made, and the whole operation of coupling up a pair of cars has been accomplished by two men in thirty-five seconds. The uppermost cable is triplicate, and serves for the reverser, lighting and heating circuits, the cars being warmed electrically. Of the three lower cables, the innermost one connects together the shoes at each end of the train, and is therefore always charged. Its connection is painted red to distinguish it from the two power cables which control the motors at the rear of the train, and are out of circuit when the car is at rest. As already stated, the third rail is to be supplied with current from substations, of which there are four, that at Formby being still incomplete. These stations are grouped more closely at the Liverpool end, where the density of the traffic is greater than elsewhere. That at Sandhills is two miles from the terminus, while the Seaforth station is three and three-quarter miles from Liverpool, Formby ten and one-quarter miles, and Birkdale sixteen and one-eighth miles. The end-sections of the line are supplied from one substation only, so that the Birkdale station has to supply current to Crossens, which is five and one-eighth miles distant. The intermediate sections are all supplied from two substations. Provision is made, it should be added, for cutting out in case of need any of the numerous sections into which the third rail is divided. The substations are situated quite close to the track, so that very short leads are necessary to connect them with the third rail. To this rail they supply continuous current at 600 to 650 volts, derived from rotary converters driven by a low-tension three-phase alternating current, which in turn is taken from the secondaries of a series of static converters, the primaries of which are traversed by a three-phase current at 7,500 volts, supplied by the generating station at Formby. At Seaforth, Sandhills and Formby there will be four rotary converters, and at Birkdale three, provision being made for extensions when required. The rotary converters are very similar in general design and appearance to the makers' standard direct-current machines. They have eight poles, and each is capable of yielding a continuous current of about 1,000 amperes at 600 to 650 volts when running at 375 revolutions per minute.

There are three static transformers for each rotary, one for each phase, and each, therefore, has a capacity of 200 kilowatts. They are wound with copper strip on edge for the secondaries which are nearest the cores, the primary coils being above and outside these. Special care has been taken to secure efficient ventilation, and the whole is enclosed in a sheet-metal casing, through which a blast of air is propelled by motor-driven fans, two of which, taking five horse-power, are provided for each substation. These fans will each yield 8,000 cubic feet of air per minute under a pressure of from two inches to three inches of water. The transformers weigh about 5,450 pounds each. The whole of the high-tension leads are kept beneath floor level, there being a special high-tension fireproof chamber below the station floor and behind the switchboard. Circuit is made and broken by oil switches located in this chamber, and operated by a long link-work from the front of the switchboard. The high-pressure measuring instruments are con-



CROSS-SECTION THROUGH A-A. PLAN OF THE POWER STATION OF THE LIVERPOOL AND SOUTHPORT BRANCH OF THE LANCASHIRE & YORKSHIRE RAILWAY.



CROSS-SECTION THROUGH B-B. PLAN OF THE POWER STATION OF THE LIVERPOOL AND SOUTHPORT BRANCH OF THE LANCASHIRE & YORKSHIRE RAILWAY.

nected to the high-tension circuits through transformers only, so that no dangerously high voltage comes on to the switchboard.

Some of the instruments have been supplied by Messrs. Elliott Brothers, but the switches and circuit-breakers have been made by Messrs. Dick, Kerr & Company at their Preston works. On the power-received panel there are three alternating-current ammeters, one for each phase, and an integrating wattmeter is mounted on the subpanel. On the transformer panels are an alternating-current ammeter, a centre-zero rotary field ammeter, a voltmeter synchronizing plug, the oil-switch operating gear, the field rheostat hand-wheel, the field break, and the field two-way switch. The rotary converter panels carry an autocircuit-breaker, and on the direct-current superpanel is an ammeter two-way paralleling plug and two single-pole knife switches, with the starting-bar coupler switch on the subpanel. On the power delivered panel is an ammeter, a two-pole change-over switch, a two-way voltmeter plug, and an integrating watt-meter. On the subpanel is mounted the rotary direct-current starter, which is a multiple contact switch connected to a grid resistance behind. There are four direct-current feeder panels, each having an autocircuit-breaker on the subpanel, a direct-current ammeter, and a single-pole change-over switch intended principally for burning out any fault in a feeder. A Garton lightning arrester and choking coil are fitted behind. Other panels support the lighting and motor switches, and another board carries the Board of Trade instruments.

The substations are connected to the power stations by high-tension cables laid in triplicate. Under ordinary working conditions all three cables are in use, but two will suffice to carry the current without too great a voltage drop or current density, in case of the third cable breaking down. These cables were made and laid by Messrs. W. T. Glover & Company, acting as subcontractors to Messrs. Dick, Kerr & Company.

The extra high-tension connecting cables are of the triple triangular type, insulated with paper impregnated with "diatrine," covered with lead, and finally armored with galvanized steel wire, which not only serves as a mechanical protection to the cable, but also makes a capital earthing conductor. The joints are of the plumbed lead sleeve type, the sleeves being filled with "diatrine." Four different sizes of cables have been used—*viz.*, thirteen miles of 37/15, six and one-half miles of 37/16, six and one-half miles of 19/15, and eighteen miles of 19/16, making a total of forty-four miles. Each of the three cores is finished off with a different color of the paper insulation, thus facilitating the making of connections. The cables have been laid in wooden troughs, where they rest on impregnated wooden supports spaced eighteen inches apart. The troughs were finally filled in with compound, and for the most part have been buried in the six-feet way. All the cables were tested to 30,000 volts between the cores and the earth before they left the works.

The power station has been erected at Formby, on the banks of the river Alt, the presence of which has facilitated the provision of condensing water.

The site, in other respects, had drawbacks, as the subsoil was mud, so that it has been necessary to "float" the whole of the buildings, boiler, and engine foundations on a concrete raft. The building, which has been erected by Messrs. Thomas Croft & Sons, of Preston, to designs furnished by Messrs. Dick, Kerr & Company, is divided into two bays, each 280 feet long; but that containing the boilers is fifty feet, and the other sixty-five feet wide. The whole of the weight of the roof and traveling cranes is transmitted to the foundation through steel columns, the brickwork being mere screens, not intended to take any extraneous weight. The steelwork was supplied by Messrs. Head, Wrightson & Company, of Thornaby-on-Tees, and the twenty-ton electric traveling cranes by Messrs. Jessop & Appleby, of Leicester.

The subcontractors for most of the steam equipment at the power station were Messrs. Yates & Thom, of Blackburn. It consists of sixteen Lancashire boilers, measuring thirty-two feet by eight feet six inches in diameter, designed for a working pressure of 160 pounds per square inch. The flues are three feet five inches in diameter, the metal in them being nine-sixteenths of an inch thick. The sixteen boilers are grouped in two sets of eight boilers each, and will be hand-fired. Galloway superheaters are fitted in the downtake flues, and Green's economizers, having a surface of 14,400 square feet, are also provided.

The boilers are worked by induced draught, a couple of fans, each capable of drawing through the furnaces sufficient air for the combustion of 10,000 pounds of coal per hour, being interpolated between the economizers and the chimney, which is sixty feet high. These fans were supplied by the Buffalo Forge Company, and are designed to run at 175 revolutions per minute, being driven by steam. The inlets measure six feet two inches in diameter, and the discharge is four feet eleven and three-quarter inches square. The fan shaft is five inches in diameter, and is supported by self-oiling and water-cooled bearings, twenty-seven inches long. The whole of the piping of the station was supplied from the Kilmarnock works of Messrs. Dick, Kerr & Company. The feed-ring is six inches in diameter, and from this branches communicate with each boiler through check-valves. The feed can be passed into the boilers either direct or alternatively through the economizers. The main steam-piping, which is of steel, is twelve inches in diameter, and is arranged so that the steam can be passed either through the superheaters into the main steam-ring or else direct through a by-pass to the engines. The exhaust-pipes are twenty-four inches in diameter, and are connected to jet condensers, a by-pass being fitted, by which, if desired, the steam can be discharged direct into the atmosphere. The four main engines are of the cross-compound horizontal Corliss type, and have, with a fifth vertical engine of half the size, been built by Messrs. Yates & Thom. They have cylinders thirty-two inches and sixty-four inches in diameter by four-foot six-inch stroke, and are designed to run at seventy-five revolutions per minute, at which they are intended to develop at normal load 2,310 horse-power, but are also capable of working under an overload of twenty per cent more. The valves are in the cylinder ends, which are separate from the barrel, the ends thus forming the steam-chest. The valves are worked by the builders' well-known trip-gear, the exhaust valves being driven by a separate eccentric.

Two Edwards air pumps are driven from the low-pressure tail-rod. Each fly-wheel is twenty-two feet in diameter, and has bolted to it the rotor of the 1,500-kilowatt three-phase alternator. These have been built at the Preston works of the contractors, and generate three-phase current at 7,500 volts direct, the periodicity being twenty-five cycles per second. The rotor has forty radial cast-steel poles, of oval section, bolted to the outer rim of two finished cast-steel rings of T-section, which in turn are bolted to a cast-iron spider. The pole tips are of laminated steel, with a central air-space, which communicates with grooves in the poles intended to secure efficient ventilation when running. The field coils are of bare copper strip, wound edgeways. Slip-rings are fitted on each side of the cast-

iron spider, and on these bear three carbon brushes. The rotor complete weighs 48,500 pounds, the poles alone weighing 12,800 pounds, and the spools 6,350 pounds. The stator consists of a cast-iron frame, carrying the core discs on its inner periphery. The core segments are of annealed iron, punched in sections, together with their paper insulation. The different sections break joint so as to reduce the reluctance. The winding is distributed over two slots per pole per phase, and was tested to 15,000 volts. The stator terminals are star-connected, with the centre point earthed. The stator complete weighs 75,800 pounds, and is mounted on slides so that it can readily be jacked away from the rotor when access to the windings is desired.

The fifth unit—which, as stated, is only half the size of the foregoing—is rated at 750 kilowatts, and is driven by a vertical cross-compound engine built by Messrs. Yates & Thom, and having cylinders twenty-three inches and forty-six inches in diameter by three-foot six-inch stroke. It is designed to develop 1,180 horsepower at ninety-four revolutions per minute.

The main switchboard is erected on a gallery over a fireproof high-tension chamber, and is built up of thirty-two two-foot panels of enameled slate. Starting from the right there are swing brackets carrying two alternating-current bus-bar voltmeters reading to 8,000 volts, a synchronizing voltmeter reading from 0 to 16,000 volts, and a synchonograph with lamps. There then come five main alternator panels, one blank panel, one total station power panel, six high-tension feeder panels for the distant substations at Seaforth, Sandhills and Birkdale; next three exciter panels, one substation total power received panel, four high-tension substation transformer panels, one blank panel, four rotary converter direct-current panels, and one blank panel. Then there is one substation total power delivered panel, including one subpanel switch for starting the rotary converter from the direct-current 600-volt bus-bars; followed by four substation feeder panels, and lastly, one station lighting and blower-motors starting panels, and swing-bracket with the rotary converter bus-bar voltmeter and paralleling voltmeter; all the substation gear being for the local substation at Formby.

The whole of the high-tension switchgear, oil switches, instrument transformers, and bus-bars are erected in a fireproof high-tension chamber below the switchboard gallery, the dimensions of which are seventy-nine feet twelve feet. Connections between the terminals of each stator and its oil switch is made by short leads to a trifurcating box in the pit, thence by a three-core high-tension lead-covered cable passing along an independent duct through the foundation up to the cellar ceiling, along which it is run by ducts through the high-tension chamber floor, where it ends in a second trifurcating box on the wall. The rest of the high-tension wiring is by individual conductors. The three-core high-tension leads are of stranded copper cable, paper insulated and lead covered. The single cables are rubber insulated, taped and braided; they were designed to pass a flash test of 25,000 volts between the phases, and each to earth. The solid copper rod high-tension bus-bars are insulated in a similar manner, and are reduced in section from the alternators to local substation panels as power is tapped.

The bus-bars and individual leads are carried on corrugated high-tension pots, connection between the oil switch and the bus-bar being made through a high-tension insulating or "hook" switch. In the instrument transformers supplied with the ammeters by Messrs. Ellicott Brothers the primary is simply a straight length of lead or bus-bar enclosed by the secondary and iron circuit. In the wattmeter current transformer supplied by the Stanley Wattmeter Company with its meters, the primary consists of a few turns in series with a bus-bar. The voltmeter transformers were built by Messrs. Dick, Kerr & Company, Limited, and the voltmeters by Messrs. Elliott Brothers, who also supplied the panels for the main board; the switches and circuit-breakers being made at the Preston works. In all cases the low-tension secondary leads pass through the ceiling to the switchboard above. The total alternating-current power generated, before passing to the substation feeders, is recorded in an integrating wattmeter. The chief feature of the alternating board is that the high-tension current is confined to the pit below the board, this being effected by the long-arm switches which are used throughout the system. The rotor field rheostats are of massive construction, and consist of cast-iron grids insulated with hard mica-nite, and assembled in frames forming layers in a vertical stack which open at top and bottom for thorough ventilation.

The Electrical Work of the British National Physical Laboratory.

At a recent meeting of the general board of the British National Physical Laboratory, a report was presented describing the work of the past year. In the department of electricity, this has been principally testing resistances, condensers and making conductivity, permeability and hysteresis tests. A number of commercial instruments were tested. In the physical department, research is being carried on as to the cause of voltage variation of the standard Clark cell. It is to be hoped that it may be possible to prescribe a method of preparing mercurous sulphate which will eliminate these conditions.

At the request of the electrical standards committee of the British association, the laboratory has undertaken the construction of a standard ampere balance designed by the late Viriamu Jones and W. E. Ayrton. The coils of the balance consist of helices of bare copper wire wound on marble cylinders, and its working depends very greatly upon the accuracy with which these coils are wound and measured.

The physics department has also been conducting tests on insulating materials for the engineering standards committee, and investigations are now in progress relating to the distribution of temperature within the layers of a field coil of a dynamo or motor.

Progress has been made toward obtaining automatic regulation of current used for testing meters.

In the metallurgical department, carbon-nickel-iron alloys are being studied, which are to be tested for conductivity and permeability.

In the thermometry division, thermo-electromotive forces of various junctions have been studied, for which purpose a good deal of material is on hand.

In the optical division, the pentane lamp is being studied, with a view to determining the conditions under which it may be treated as a standard. The next work will relate to the establishment of primary standards.

A Question for Telephone Men.

To the Editor of the Electrical Review:

Will you please answer in your columns the question asked herewith?

A ground-return line has about fifteen telephones connected upon it. Some of these telephones will call all the others; some of them may be called by all the others; some of them call part of the others, but, for some reason, will not call them all. What is the cause, and how may it most easily be remedied? The telephone company claims that the magnetos and bells are all wound alike; *i. e.*, with the same resistances. W. H. R.

April 2.

AROUND THE INTRA-MURAL.

ROUTE WHICH THE WORLD'S FAIR VISITOR WILL FOLLOW IN A TROLLEY RIDE AROUND THE GROUNDS.

BY FRANK L. MERRICK.

When the visitor to the World's Fair in 1904 is whisked over the six miles of the Intra-Mural railway in forty-five minutes, making the circuit of 1,240 acres of exposition area, he will not only be carried to his destination quickly and without fatigue, but will be able to obtain, en route, a comprehensive view of the grounds and buildings.

Boarding a car at the main entrance and going west interesting sights will present themselves in rapid succession, and one's eyes are kept constantly busy throughout the entire trip.

First comes the Pike. For about a mile the road runs parallel with the amusement street. True, it is at its backyard, but the peculiar architecture of the buildings, gaily decorated with the colors of foreign nations; the loud cries of the barkers; the confused commingling of many airs played on all kinds of curious instruments, and the joyous laughter of the Pikers, all arouse one's curiosity and make one impatient to join the merry throng. To the left are the imposing northern façades of the palaces of Varied Industries and Transportation. To see the cornices of these structures one must stoop and crane his neck upward out of the window. One can not see the tops of the towers on the Varied Industries Building while seated in the car, so high are they.

Next, the road runs to the right of the group of foreign government buildings with their characteristic architecture, and further on the Washington University group standing on a plateau. The Administration Building is in the centre facing the east. Its massive Tudor-Gothic architecture, worked out in enduring granite and Indiana limestone, reminds one of a castle in England of the time of Henry VIII and Queen Elizabeth. Passing these structures the road hugs the northern fence until it reaches the athletic field in the extreme western end of the grounds. It curves around the stadium, runs east and then south, passing the Indian reservation where one can see the villages of the red men, which will probably be the last exhibit of the copper-colored race.

Running east again one passes an interesting feature—the largest geographically correct map of the United States ever constructed. The map is made of representative growing crops of each state and covers six acres. On the right is Laguna de Bay, on the shore of which are the Moro villages and other features of the Philippine exhibit. The houses of the Moro town, representing a section of our eastern possessions, are built on poles over the water. The natives use boats as a means of transportation, and their front doors are reached by ladders.

One may learn the time o'day as he runs by the Palace of Agriculture. On a gentle slope, to the south, is a clock—the most wonderful timepiece ever constructed, the largest time-telling device ever built, which appears to be made entirely of flowers. The mechanism is buried in the hillside so that the flowers themselves appear to tell the time. The dial is 100 feet in diameter. The minute hand is fifty feet long, and the numerals are fifteen feet high.

The car then runs south for half a mile on Skinker road, that old pike which was used many years ago as a highway by the country folk. On the right is the eastern façade of the Agriculture Palace, 1,660 feet long. Here the air is fragrant with the perfume of a million roses. A rose garden, six acres in area, with 60,000 bushes in bloom, lies before the visitor in front of the Agriculture Palace. On the left is the tree-covered slope of Camp Hill, with a glimpse here and there of the California and Illinois state buildings, and the Temple of Fraternity.

Further along the immense conservatory of the Palace of Horticulture comes into view. Then the live-stock pavilions and silos.

Turning off Skinker road near the southern fence and running east, the road plunges into a veritable forest. This portion of the grounds, with its abundance of shade, its green foliage, and its rolling hills, is a quiet and restful retreat from the life and motion of the "main picture." Chicago, or any other previous exposition, possessed no such sylvan retreats, where the tired sightseer could steal away from the crowds, find a secluded nook and commune with nature.

The road winds in and out through the trees, dashes over long trestles and crosses deep ravines. One inhales the delightful odor of the country. The environments are exhilarating.

In one place the road runs near the rear of the Art Palace. Through the trees one can see the marblelike balustrades of the broad verandas surrounding it.

Further the road passes the "mining gulch." Here are mines of all kinds in operation. A typical '49 California mining camp is there. Oil-well derricks tower above the summit of the ravine. Further on is a tall shot tower. This outdoor mining exhibit will be full of life and motion, and will afford the first opportunity any one ever had to see in one place operations accurately illustrating the various methods of mining and metal working.

Near the journey's end comes the "Inside Inn," a 2,500-room hotel, with accommodations for 6,000 guests. The road runs northward and to the east of the state buildings on the Plateau of States. Here twenty-nine states and territories have erected beautiful houses in a forest to serve as state headquarters at the fair. The visitor passes the United States Government Building, the largest structure ever erected by Uncle Sam at an exposition. Then comes into view the Liberal Arts Palace, the Parade Entrance, and the eastern end of the Main Transverse Avenue with the Triumphal Causeway, and one has reached the outskirts of the "main picture." In a few minutes more the northern façade of the Manufactures Palace is passed and the trip comes to an end close to the main entrance where the start was made.

On this journey one has only touched the "main picture" in a few spots, but frequently a glimpse of the sky-line of the exposition is seen, with the towers and turrets of the City of Knowledge lifting themselves skyward.

National Electric Light Association.

The following companies have been added to the line of active members of the National Electric Light Association: the Boulder Electric Light and Power Company, Boulder, Col.; the Sheboygan Electric Light and Power Company, Sheboygan, Mich.; the Montevideo Electric Light and Power Company, Montevideo, Minn.; the Indianola Ice, Light and Coal Company, Indianola, Miss.; the St. Joseph Railway, Light, Heat and Power Company, St. Joseph, Mo.; the Bellevue Light and Power Company, Bellevue, Ohio; the Massillon Light, Heat and Power Company, Massillon, Ohio; the Darlington Light and Water Company, Darlington, S. C.; the Beaumont Ice, Light and Refrigerating Company, Beaumont, Tex.

Mr. Frank W. Frueauff, auditor of the Denver Gas and Electric Company, has been asked by President Edgar to report on office methods and accounting at the twenty-seventh annual convention of the association, to be held in Boston, May 24 to 27.

Dr. S. S. Wheeler has been requested to act as chairman of the committee to examine the papers of those competing for the gold medal offered by Past-President Doherty for the best paper on underground construction. Dr. Wheeler has consented to serve, and other members of the committee will be Mr. Louis A. Ferguson and Mr. H. G. Stott.

WIRELESS NEWS SERVICE ACROSS THE YELLOW SEA.

AN INTERESTING BIT OF HISTORY CONCERNING THE RUSSO-JAPANESE WAR.

BY JULIUS CHAMBERS.

War is in active progress in the far east; the attention of the entire world, civilized and uncivilized, is focused on the result. But another struggle for supremacy has been going on around the Yellow Sea since the first of this year, in which the public has more than a commercial interest. Although nothing has been written about the matter, because its success was only assured last week, every reader of the daily papers is vitally interested.

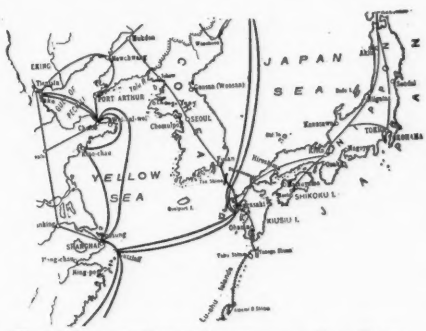
I refer to the news campaign now in progress at the seat of war. Neither expense nor energy is spared by the leading journals of this country and England to place correspondents at points of greatest vantage. But American newspapers have failed to make proper preparations for getting their information to the home market. Thackery said: "It is one thing to write a book, another to get it printed." The same thing is true of news. The most important bit of information is valueless if the censor will not permit it to be forwarded. This was the problem that Captain Charles Blakely, a long-time representative of the London *Times* in the Orient, attempted to solve.

In anticipation of inevitable war Captain Blakely left Pekin in December last, and hurried to London to procure a wireless telegraphic outfit. He had much trouble in convincing the managers of the London *Times* that the conflict was about to break out, but he was finally authorized to procure engines and dynamos and ship them to the far east. After a week's search Captain Blakely was unable to find the plant he needed and came to New York in search of it.

His plans may now be stated without violating confidence. The Yellow Sea is a comparatively small body of water. It is only 175 miles broad at its widest point. The coast of Corea defines its eastern limits.

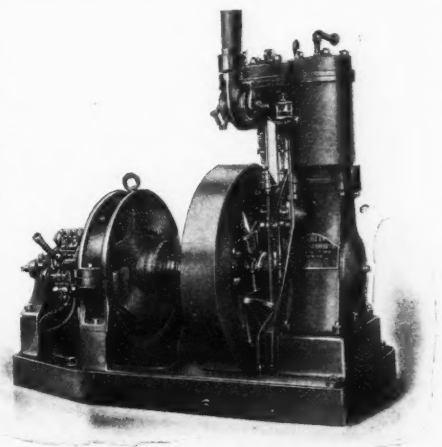
The problem that presented itself to Captain Blakely was to connect the various news centres with the British cable station at Wei-hai-Wei by a wireless service across the Yellow Sea. Just north of the Bay of Chemulpo is a headland that projects from the Corean coast many miles into the Yellow Sea. At this point Captain Blakely intended to set up his Corean station, connecting it with Seoul by an extension of the land lines already in operation. He confidently hoped, also, to hire an ocean tug in which he would be able to traverse any part of the Yellow Sea and which would be equipped with the tall mast and other wireless telegraphic apparatus. In this boat he hoped to be able to witness the naval battles and maintain a continuous connection with London.

In selecting Wei-hai-Wei rather than



WAR MAP OF CABLE SYSTEMS IN FAR EAST.

Tokio as the point from which to send news, censorship is avoided. The cable system from there to London is the only one with which the belligerents dare not interfere. It is British in ownership and management. It follows the Chinese coast to Hong Kong; thence to the Malay peninsula, which it crosses to Singapore; thence under the Indian Ocean and across



THE GENERATING SET FOR WIRELESS TELEGRAPH OPERATIONS AT CHANG-YONG, COREA.

India to Bombay; next under the Bay of Bengal to Aden; up the Red Sea to Suez, across Egypt and under the Mediterranean to the Continent by half a dozen routes. Therefore Blakely reasoned well when he determined to make Wei-hai-Wei his news base.

Captain Blakely arrived in New York the first week in January and, acting on information obtained at the army headquarters in this city, purchased two combined oil engines and dynamos from the General Power Company, which has offices in the Fulton National Bank Building, at Fulton and Gold streets, and a factory at Harrison, N. J. The success of similar engines in the wireless telegraphic service maintained during last summer's naval manœuvres at the eastern end of Long Island was so complete that the commanding officers gave their endorsement.

The dynamos, of fifteen kilowatts, were supplied by the General Electric Company and were attached directly to the engine shaft. A picture of the combined plant is shown on this page.

Within three days of the receipt of the order from Captain Blakely the General Power Company shipped the two engines from this city to Montreal, whence they were rushed by special express over the Canadian Pacific Railroad to Vancouver. A deposit of $500 was made by Captain Blakely as a guarantee for the payment of the extra transportation rate demanded by the railway officials. The equipment left the British Columbian port for Yokohama on January 15, arrived at Japan on February 5, and was promptly forwarded by English steamers to Wei-hai-Wei.

The station at that point has been ready for use since the first of March, but unexpected opposition attended the establishment of the Corean post, owing to the strict press censorship instituted by the Japanese invaders of that peninsula. The original intention to establish a station at Chang Yong, a village near the western end of the Corean headland previously mentioned, has not yet been carried out because of the impossibility of making the necessary land-wire connections. At present the second plant is carried upon an English tug, hired at Hong Kong, and several messages of the highest value have been transmitted from various points in the Yellow Sea through the Wei-hai-Wei station. The London *Times's* tug has been hovering about the Japanese fleet near Port Arthur and on several occasions has been under fire.

The mystery of the wireless service in the Yellow Sea is herein explained for the first time. Captain Blakely deserves success because he has been more far-sighted and enterprising that his American or English rivals.

Electrical Notes from India.

The city of Rangoon, Burmah, has awarded the contract for installing an electric light and power plant and electric railways to the Brush Electric Company, England. Work, however, has not yet begun, as an agreement has not been reached concerning certain concessions which the city wishes the Brush company to make.

The fine granite palace of the Maharajah of Mysore is being equipped throughout with electric lights, electric fans, electric elevators and other appliances.

A. C. H.

Sivasamudram, South India, Feb. 23.

Rubber Insulation.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In the ELECTRICAL REVIEW for April 2 is published an article entitled "Rubber Insulation," which appeared originally, in the *Railroad Gazette*. As the subject is of much importance, I feel justified in referring to it in detail.

The article is not only misleading in the presentation of its alleged facts but it is amusingly so in the conclusions arrived at. In fact, I am compelled to say that reduced to its logical deduction, the whole intrinsic substance of the article is to show that good wire is an economic fallacy, and poor wire an economic asset. Tests, it says, furnish no evidence of excellence; chemical analysis furnish none; in short, there is nothing whatever to guide one, but the mere reputation of the manufacturer. These are, indeed, surprising statements to come from any one possessing even an elementary knowledge of insulation; and the only way to account for them is that the writer had an axe to grind or a grievance to ventilate. That this latter hypothesis possesses all the appearance of truth, is pretty clearly shown by the gratuitous and wholly unwarranted statement that a seam or ridge in the insulation is a "source of weakness." In other words, seamless insulated wire is the only reliable wire, and all wire having a seam or ridge is unreliable and unworthy of confidence.

Now, I happen to be familiar—sufficiently so to hazard an opinion and to offer proof—with a very good wire that is always made with a ridge. This make, too, happens to be, oddly enough, the highest priced wire on the market, and, further, I know it to be used extensively and almost exclusively by some of the best known engineers and largest users of insulated wire in this country. I think an insulation, even though it is not seamless, that can pass the exacting tests of the Navy Department, and be used for United States warships, is a pretty convincing refutation that a seam or ridge is a "source of weakness."

The truth is, there is no secret about the manufacture of good insulation. It is fundamentally a question not of a seam or no seam, but one of rubber. To be sure, each manufacturer individualizes his insulation by certain methods of compounding and makeup, which constitutes, what might be called, characteristic traits. These are questions of individual preference or private opinion, which each one has to settle for himself, but which have only an indirect bearing on the intrinsic and underlying merit of the insulation itself. The rubber in the compound is the really vital thing. It is this, properly associated with other materials, that will show the highest electrical and physical tests, that will survive indefinitely under all the trying and varying conditions of wind and weather. In short, Para rubber bears about the same relation to good insulation that good blood bears to the human system. Their presence, respectively in the one as in the other, denotes efficiency and vitality; their absence, debility and premature decay.

This brings us to the question of tests. Are tests—that is, insulation, voltage and elongation—indicative of the character of the insulation? They are, most indubitably. There is a direct relationship between the character of the insulating compound and the electrical and physical tests this compound will stand. Of course, these tests must be properly carried out. A dry test—that is, a test for insulation resistance and voltage before the insulation has been properly soaked, or after it is taped, braided or leaded—furnishes not the slightest criterion of merit in any wire. In fact a weatherproof wire will, under these conditions, show up initially well. But soak that same wire for, say, forty-eight hours antecedent to the test, and what showed surprising strength before will, under the altered conditions, dwindle to a mere nothing. Now this is characteristic of all tests for insulation, under the conditions indicated. The tests are bound to furnish a criterion, approximately accurate, of the compound employed—that is, the insulation resistance and voltage rise or fall in proportion to the quantity and quality of pure Para rubber employed in the compound. Take for example No. 14 B. & S. wire with one-sixteenth-inch wall of insulation. This compound if it contains, say, thirty per cent of Para rubber will easily show the following tests at a temperature of sixty degrees Fahrenheit: insulation resistance, 1,500 megohms per mile, at 2,000 volts. Now take this same size wire with one-sixteenth-inch wall of some cheap compound or even of the cheaper grades of rubber and you can not, by any artifice, get anything like the tests referred to for the pure Para. It is true that the cheaper grades of rubber will often show up surprisingly well in an initial test. But subject these to a more prolonged soaking, and their insulation quickly and markedly deteriorates.

The writer of the article already referred to is particularly distressed over a certain engineer's specifications, whose name he does not mention. His offence consists in calling for an elongation test of the insulation to four times its original length—that is, a piece of insulation four inches long shall stretch to sixteen inches without break or rupture. This is, undoubtedly, a severe test, but by no means an impossible or even an unusual one. I have repeatedly seen high-grade insulation stretch to this dimension, and I think, therefore, that the engineer who demanded this test in his specifications was much better informed on what he was doing than the writer alluded to knew what he was saying, who is evidently not familiar with current, and now very generally accepted, practice; or if he is, he seemingly resents a new and distinct advance in the art of testing wires and cables. For this elongation or stretching test, while comparatively new, is by all odds one of the best, if not the very best test for dielectric excellence yet devised. A cheap compound, or an inferior rubber, may, under favored circumstances, show misleadingly high electrical tests. But it is practically impossible to be deceived by an elongation test. This determines with fully as much accuracy, I believe, the quality and quantity of Para used as a chemical analysis does. It is simpler, quicker, can be done anywhere and by any one. The Navy Department employs it as one of three correlated tests on every wire and cable purchased, and I know that the wires it gets under these tests bear unmistakable evidence of the highest dielectric efficiency. It is, therefore, highly absurd for any one to say that there is no necessary relationship between elongation and the best electrical results. Where there is rubber there is elongation; and where there is no rubber there is no elongation.

It must not, however, be assumed that elongation alone is indicative of faultless insulation—not at all. Its object is to show that the composition of the insulating compound is nourished by a large admixture of Para rubber. But it is obvious that, no matter how vigilant a manufacturer may be, mistakes will be made and imperfections creep in, which, however, can always be detected by a proper test for insulation resistances.

CABLE ENGINEER.

New York, April 4.

A Joint Meeting of Electrical, Gas Lighting and Railway Associations.

The Southwestern Electrical Association, of Oklahoma and Indian Territory, and the Southwestern Gas, Electric Light and Street Railway Association, of Texas, Louisiana and Arkansas, will hold a joint meeting on April 25, 26 and 27, at Dallas, Tex. Every one connected in any way with electric light plants, telephone exchanges or street railways, or supply men, is invited to meet with the associations at this time. The electrical men of Dallas are making preparations to afford to all visitors an exceedingly pleasant time.

A TEST FOR INDUCTION MOTOR WINDINGS.[1]

BY G. H. GARCELON.

The standard winding for an induction motor primary is shown in detail in the photograph, Fig. 1. The winding may be considered as made up of units or "groups." The coils of one phase for one pole compose a group, the number of groups in a winding being equal to the number of poles multiplied by the number of phases.

The different coils in each group are all connected in series, so that current flows through them in the same direction, by means of short connectors between the coils called "stubs;" the group is very similar to the field coil of a direct-current motor, except that the different turns are distributed in several slots. The different groups of each phase are connected together, so that current passes through alternate groups in opposite directions, thus producing alternate north and south poles; they may be connected all in series or in equal parallel circuits, depending principally upon the voltage at which the motor is to operate. There can be as many circuits in parallel as there are poles.

In a three-phase winding, the phases are connected together, one end of each phase being brought to a common connection and the other three ends serving as the terminals of the motor. In a two-phase winding, the phases are usually separate, all four ends being brought out as terminals.

The connections of a three-phase, four-pole winding are shown in Fig. 2, each coil representing a group. By following out the winding, it will be seen that one end of each phase is brought to the common connection Y, the other three ends forming the terminals of the winding; it will also be seen that the phase B is connected in the reverse direction from phases A and C. This is the form of connection used in practically all three-phase induction motor primaries and is called the Y or "star" connection.

Fig. 3 is a diagram of connections for a two-phase, four-pole winding. The phases are entirely separate and the winding is simply two single-phase windings. Therefore it is much simpler to connect and test than a three-phase winding.

The winding errors which occur are wrong connections between groups, resulting in a reversed group or even a reversed phase; the accidental use of wrong coils, usually coils having a wrong number of turns; short-circuits in the coils; or open-circuits in the coils. Mistakes arising from wrong cross-connections rarely get past the winding inspector, as they are easily detected by an inspection of the winding. The common errors which develop in the winding test are the hidden ones—short-circuits, open-circuits, and wrong coils—which can only be detected electrically.

A test employing direct current might be used; the effect, however, of some of the common faults, a short-circuited coil, for example, upon the ohmic drop is so small that defective motors would often be passed. By using alternating current, not only is the ohmic drop affected by errors, but also the inductance, thus magnifying the defects. The higher frequencies are of course used, as a larger impedance drop can be obtained with the same current flowing.

The test is based upon the fact that any error in the winding will destroy the symmetry of the magnetic field produced by the winding when single-phase alternating current is passed through it. This, in turn, will affect the impedance of the winding. The test may be best described in connection with a three-phase winding; the application to a two-phase winding will be obvious. Referring to Fig. 2, suppose the terminals A and B to be connected to a single-phase alternating-current circuit, current will flow through phase A to the common point Y, thence through phase B back to the line. The arrows designate the instantaneous direction of the current. From this it is seen that the current in phase A is flowing in the same direction as that in phase B, where the conductors of the two phases are adjacent. Therefore the two phases are assisting each other in magnetizing the core. If the current was applied to A and C or to B and C the same effect would be produced.

The rectangles at the top of Fig. 4 represent the developed cross-section of the winding. The two rectangles similarly cross-hatched represent the two sides of the coils of the same group. The field due to the group A will be between A and A' with a maximum half-way between.

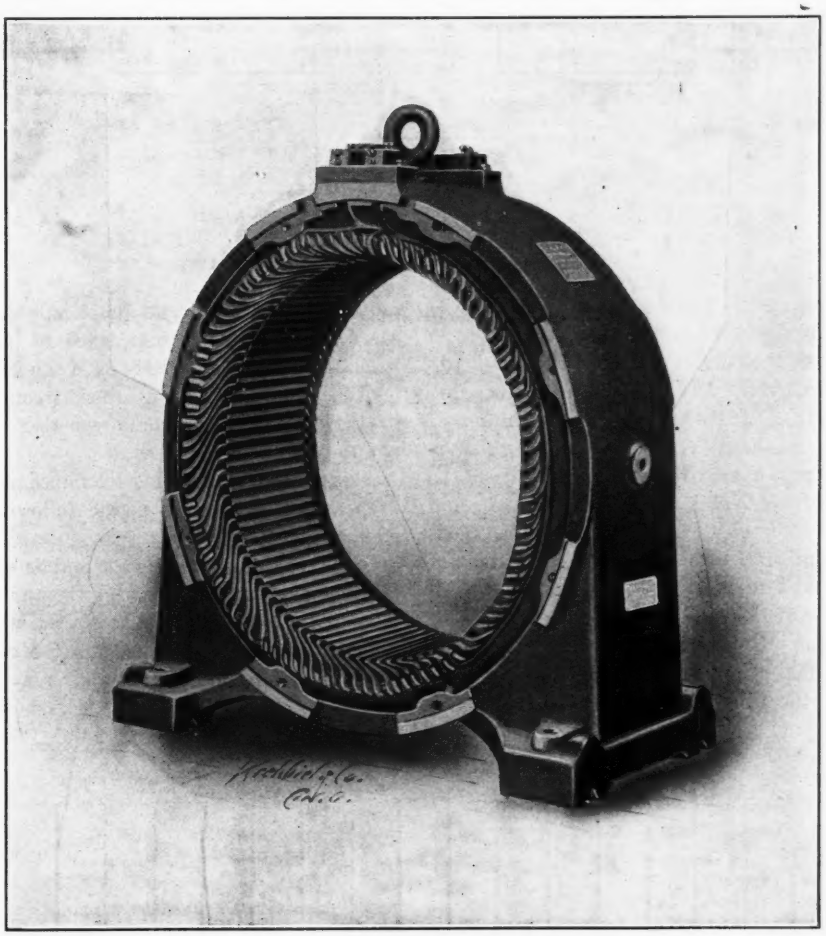


FIG. 1.—INDUCTION MOTOR PRIMARY.

[1] Reprinted from Electric Club *Journal*, April 2, 1904.

Similarly the field due to the group B will be between B and B and have its maximum at the centre. Since the current is in the same direction in the adjacent conductors of each group the fields will also be in the same direction. Assuming theoretical field-forms and plotting in the positions just noted, we obtain from them the resultant field-form from the correct winding, shown at (*a*) of Fig. 4. Any mistake in the winding will affect the symmetry or position of the resultant field-form. Suppose, for example, phase B be reversed. Then the field due to each group of that phase would be reversed. Fig. 4 (*b*) shows the field-form of B reversed, also the resultant of A and reversed B. The form and position of the resultant are changed. If one group of phase B is reversed the field due to that group will be reversed, while those of the other groups remain unchanged.

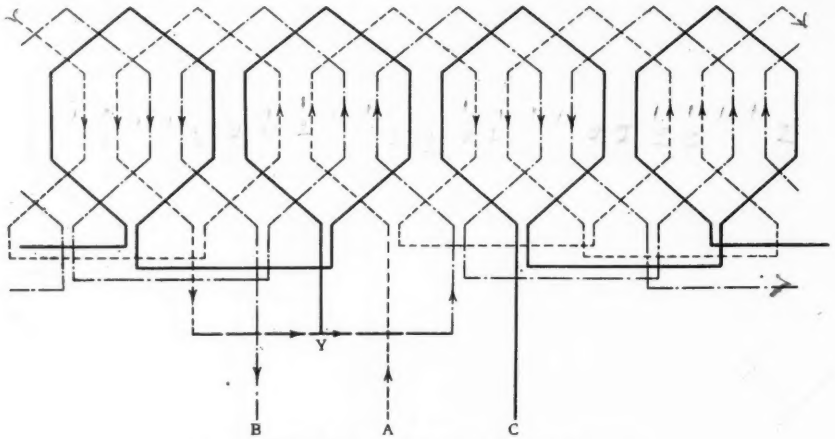


FIG. 2.—THREE-PHASE INDUCTION MOTOR WINDING.

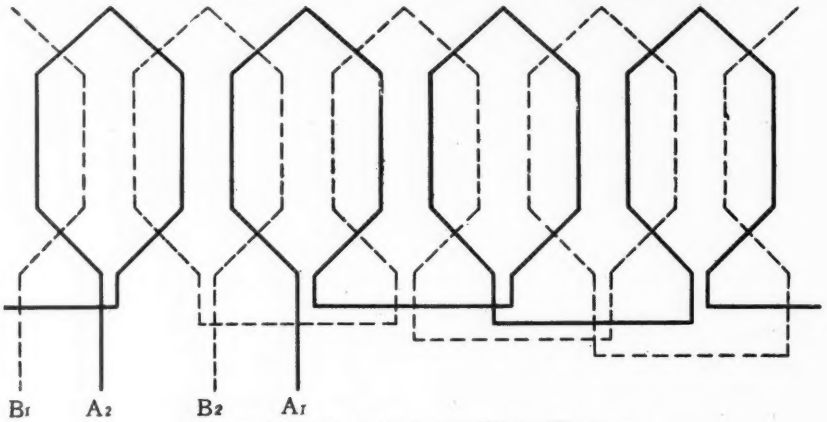


FIG. 3.—TWO-PHASE INDUCTION MOTOR WINDING.

This will cause a distorted resultant field at the pole containing the reversed group. The distorted field-form due to such an error is shown at (*c*) of Fig. 4. The smaller errors, short-circuits, etc., affect the symmetry of the field in a similar way, but to a smaller extent. It may be of interest to note that the different field-forms shown in Fig. 4 have been verified experimentally by means of an exploring coil.

Any change in the amount or distribution of the magnetic flux produced by the winding means a corresponding change in the self-induction and practically the same change in the impedance of the winding. This fact is the basis of the first test made on the winding when it comes to the tester—to determine whether or not the winding is correct.

This is done by observing the impedance drop across each phase in the following manner:

Single-phase alternating current is applied at any two terminals of the three-phase motor. This, as we have seen, will cause a flow of current through the two phases connected, and will produce symmetrical fields at each pole, as shown in Fig. 4 (*a*). Since each phase is of the same number of turns, is similarly wound and carry the same current, the impedance drop across each will be the same, if the winding is correct. Also, if the winding is correct, the phase whose free terminal is not connected to the supply circuit is so situated with respect to the magnetic field produced by the other two phases that there is no electromotive force induced in it; in other words, it acts simply as a potential connection to the common point of the three phases. The coils of phase C embrace equal positive and negative parts of the resultant field produced by A and B, as shown by Fig. 4 (*a*).

Fig. 5 shows the circuit diagrammatically, A and B connected to the supply circuit and C free.

By changing the supply mains to A and C, then to B and C, and taking voltage readings, all the phases are verified. A set of readings similar to the following

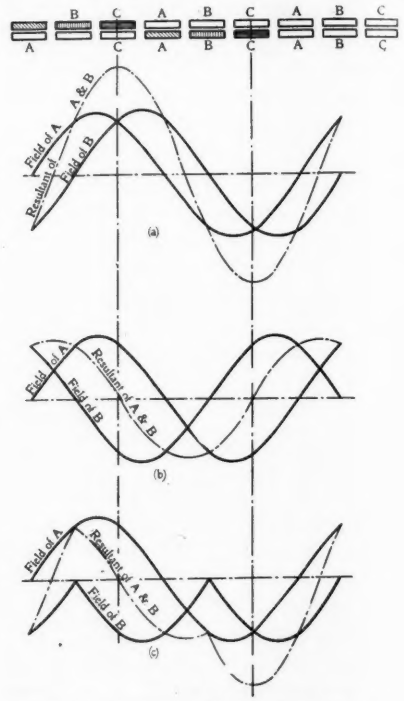


FIG. 4.—INDUCTION MOTOR FIELD-FORM.

would result, any variation showing an error of some sort in the winding:

Current Applied to.	Amperes.	Volts. A—B.	Volts. B—C.	Volts. A—C.
A—B	14.7	70	35	35
B—C	14.7	35	70	35
A—C	14.7	35	35	70

If these readings indicate an error, then the second part of the test—the location of the error—must be made. It has been pointed out that the field-forms should be symmetrical for a correct winding. If the winding is faulty, irregularities will exist in the form of the field at the points where the fault is located. The field-form may be obtained by moving an exploring coil around the core. A simpler way is to measure the drop from stub to stub, the stubs being easily exposed by removing the tape. These drops should be alike for each coil symmetrically lo-

cated with respect to the poles. The reading which varies locates the error in the coil between the stubs giving it. This procedure is necessary to locate the common faults, but it will be interesting to see how such mistakes as a reversed phase or a reversed group affect the first part of the test and locate themselves at once without an application of the second or locating test.

Let us suppose phase B to be reversed, and current fed to A and B. The voltage readings would of course be A—C and B—C, which should be equal. However, the phase C is not idle in this case, but embraces the entire resultant field of A and B, as shown in Fig. 4 (*b*). The electromotive force induced in C is approximately equal to one-half the impressed voltage A—B, because the resultant field is nearly equal to that of either A or B alone. This will make the voltage A—C approximately equal to A—B, the impressed voltage. The voltage B—C will be zero, or nearly so, since the electromotive forces B and C are opposed and nearly equal. With current in B and C

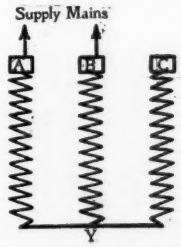


FIG. 5.—INDUCTION MOTOR WINDINGS.

the readings will be similar, while with current in A and C they will be normal, since the reversed phase is then inactive. The readings are given below. In this and all following examples the small letter indicates the defective phase.

Current Applied to.	Amperes.	Volts. A—B.	B—C.	A—C.
A—*b*	31.2	70	0	70
b—C	31.2	0	70	70
A—C	14.7	35	35	70

The results when a group is reversed are similar, although less marked.

If a coil is connected with the wrong group, the voltage of one phase will be high while that of another will be low, since, if the coil is not in the right group, it must be in an adjacent group, and consequently in another phase. This mistake is easily located by counting the stubs in each group, and, therefore, rarely reaches the winding test.

One or more short-circuited coils will lower the impedance of the phase containing them, owing to the decreased inductance caused by the induced current in the short-circuited coils. The table shows the results of such a case:

Current Applied.	Amperes.	Volts. A—B.	B—C.	A—C.
A—*b*	15.5	70	34	36
b—C	15.5	34	70	36
A—C	14.7	35	35	70

Short-circuited coils can sometimes be burned out, otherwise the location test will be necessary.

An open-circuited coil will be evident at once, since no current would flow in that phase.

Poor contacts between coils will give an increased drop across the phase containing them. By stripping the tape from the stubs they may be readily located without further testing.

A few coils made up of the wrong number of turns are occasionally placed in a winding. This causes only a slight unbalancing of the phases and is probably the most difficult error to detect. An example of an error of this sort in a two-phase winding follows. Current taken in each phase repeatedly with the same applied voltage was:

$$A_1 - A_2 = 41.2 \text{ amperes.}$$
$$b_1 - b_2 = 40.3 \text{ amperes.}$$

The cross-connections were examined and found correct. The drop across each phase was then taken with the two phases in series. B_1—B_2 was the higher, showing too many coils to be in phase B or too few in phase A. The drop across each group was then measured, indicating two groups in phase B with too small a drop. Next the drop across each coil was taken. These readings should begin low at the edge of the group, increase steadily to a maximum at the other end or beginning at a maximum, decrease steadily to a minimum. They did not do so. The drops of the coils of one group are given, also those of a correct group:

Coil.	Volts. Correct Group.	Faulty Group.
1	2.72	2.71
2	3.22	3.21
3	3.75	3.73
4	4.00	3.98
5	4.10	3.83
6	4.15	4.13

The readings across the faulty group increased steadily until coil (5) was reached. This drop was low, showing too few turns in that coil. These readings were obtained with both phases in series. If only one phase was connected to the line the readings would increase to coil (3), coil (4) being the same as (3), then decrease symmetrically; (5) equal to (2) and (6) equal to (1). The field due to the second phase when both are in series causes the difference. Another coil of too few turns was found in the other group which gave a small drop.

The photograph, Fig. 6, shows the switchboard used in making these tests. Fig. 7 is a diagram of the switchboard connections. The board is fed from a

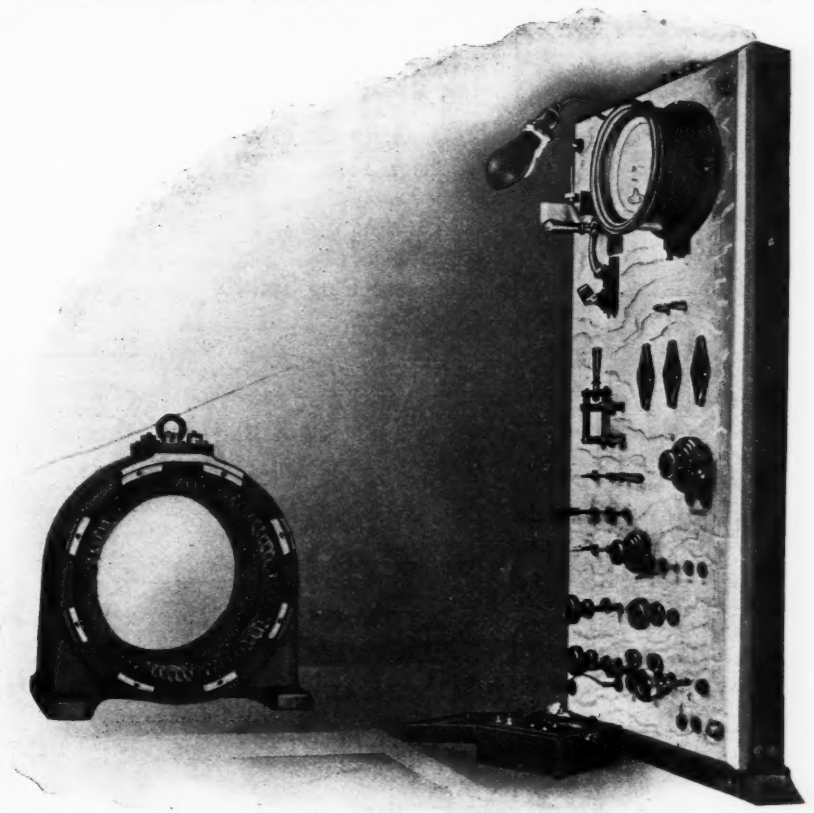


FIG. 6.—TESTING SWITCHBOARD.

220-volt, 7,200-alternation circuit. This enters, through a circuit-breaker and switch, to the primary of a ten-kilowatt transformer. The secondary of this transformer is wound for 465 volts and provided with thirteen taps leading to as many plug-sockets. The voltage between the taps is given in the figure. By inserting the plugs in two of the sockets any voltage, varying generally by five-volt steps, from five volts to 465 volts is obtained. These variations are necessary to obtain a proper current in the different types of windings. The ammeter has ten and sixty-ampere scales, being connected to the two series transformers. Either series transformer is put in circuit and the other cut out by changing one plug from one to the other of the two three-part sockets. It is also impossible to open the secondary circuit when the primary is in circuit. By means of the four-plug switches and the single-pole double-throw switch the supply circuit can be connected to any phase of a three-phase or two-phase motor without changing the connections at the motor. The four voltmeter sockets enable any voltage to be read independently of the current connections.

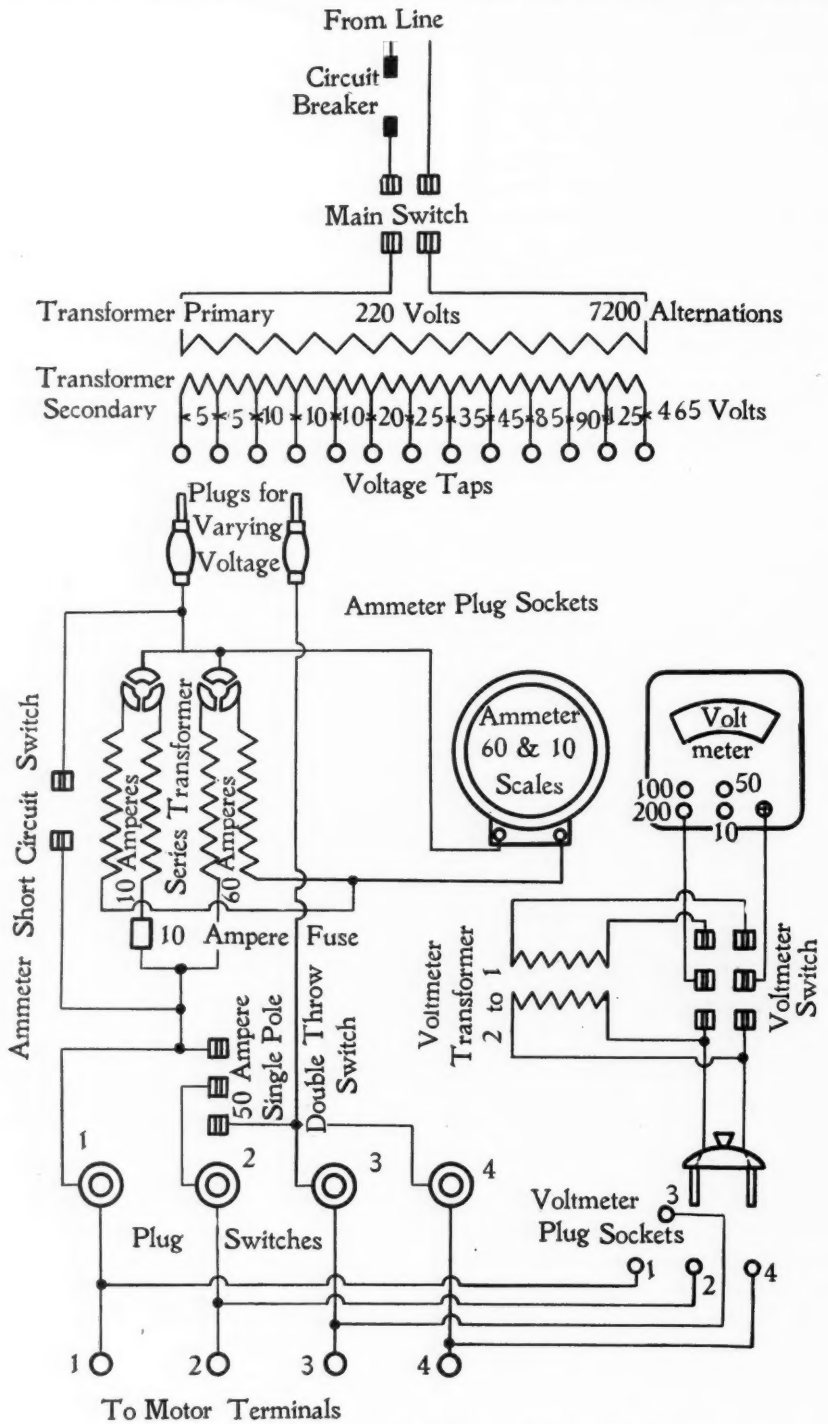


Fig. 7.—Connections of Testing Switchboard.

An example will serve to explain the operation of the board. A three-phase winding will be taken. The three motor terminals are connected to leads (1), (2) and (3) from the board, and no further attention to the motor connections is necessary. The voltage is adjusted to suit the winding on test. If seventy-five volts give a convenient current the plugs are connected to taps (3) and (8) of the transformer. The ammeter scale, sixty or ten, is chosen, which gives the best deflection. If it is the ten, the ammeter plug is inserted in the socket at the left. Say we wish to first feed current to phases A and B. Throwing the single-pole switch down and closing the plug switch (2) connects the socket (2) to which phase B is wired. Then by closing plug switch (1) A is connected. By opening the ammeter short-circuiting switch the current A—B is observed. For seventy-five volts the 100-volt scale of the voltmeter is used without the voltmeter transformers, so the voltmeter switch is thrown down. Putting the voltmeter plug in sockets (1) and (2) we have the voltage A—B. Changing to (1) and (3) gives the voltage A—C, and to (2) and (3) gives the voltage B—C. These are all the readings necessary with current in phases A and B. Opening plug switch (2) and closing (3) will put the current in A and C. The voltage readings are similar. Throwing the single-pole double-throw switch to the upward position, opening plug switch (1) and closing (2) puts the current in B and C, and the voltmeter readings are repeated. This is all the manipulation for the complete set of observations, providing the winding is correct. If it is not correct, the current may be sent through the required phases and voltmeter leads carried to the motor and the drops taken which are necessary to locate the error.

Does Not Like the Electric Light.

The following interesting communication speaks for itself:

Schenectady, 23/11, '03.

Schenectady Gas Company.

Dear Sir—I wish you please connect me with the gas meter. The meter is in the house and globes are here to. We got the electric light but it gus out to often. I like to use the gas meter by 25c worth. Yours respectfully,

E. J. M.

THE BERLIN TELETYPING CENTRAL STATION.

BY DR. ALFRED GRADENWITZ.

On October 1, 1903, a most valuable addition to the Berlin telephone, with its nearly sixty-eight thousand subscribers, was made, when the Ferndrucker-Centrale was opened to public service. Telephones, which only render words as they are spoken, are frequently inefficient for business purposes; in addition to a correct transmission of a communication, there will, in many cases, be necessary an acknowledgment in writing of this transmission. On the other hand, there is the liability of telephonic conversation being overheard by a third party, and finally the person rung up on the telephone may happen to be absent, when his return will have to be awaited for and much time lost. In all these cases, the new teletyper service is intended to afford efficient means of communication.

The teletyper (Fig. 1) as constructed by the Siemens & Halske Company is a type-printing telegraph, similar to the well-known Hughes type printer and the Baudot telegraph. The main distinctive feature from former apparatus is, however, the fact that the latter moving freely, the synchronism of the instruments established on the same line had to be obtained by the skill of the operator, whereas the operation of the new apparatus being nothing else than a teletype-writer may be learned by anybody in the shortest possible time. The keyboard of the teletyper (Fig. 2) is similar to that of an ordinary typewriter, comprising four superposed rows of seven keys each, out of which twenty-six are each provided both with a letter and a figure or sign of punctuation. As regards the remaining two keys, one serves as beginning or letter key, whereas the other, bearing the inscription "Zahl," is used as figure or punctuation key. By striking either of these keys, the type-wheel of the printing telegraph is adjusted either for letters or figures in a manner similar to the Hughes apparatus. Both of the apparatus connected by a line may be used either as sender or as receiver without any special preparation or switching being necessary, both of them being automatically and simultaneously operated as soon as the first white key is struck, when the apparatus in question becomes a sender, and all is ready for use.

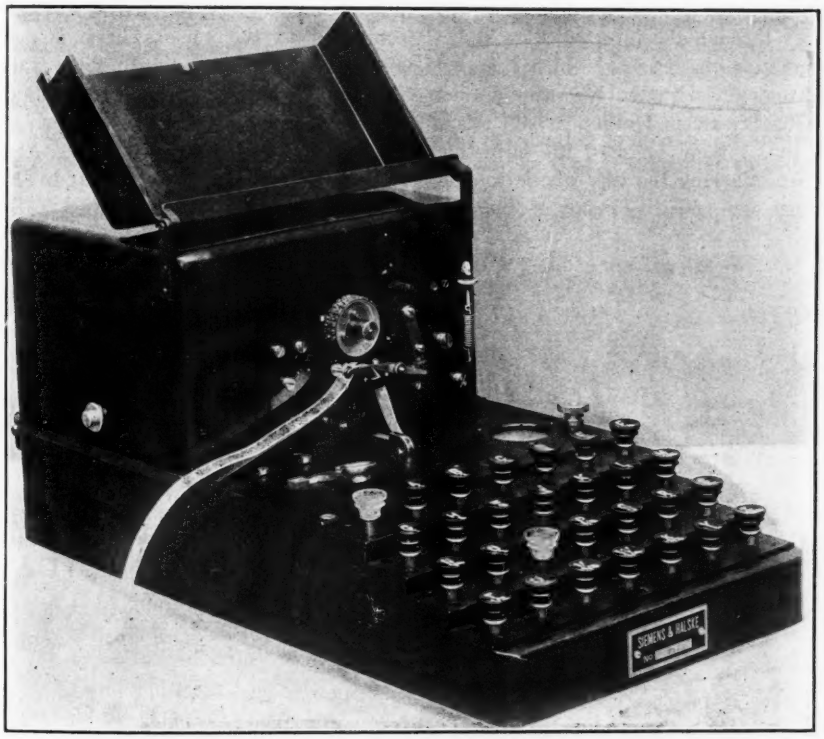


FIG. 1.—THE TELETYPER, INSTALLED IN BERLIN, GERMANY.

The type-wheel bears on its periphery, in one circle, the letters and in another parallel circle the figures and signs of punctuation. On acting on the shift key, the type-wheel is shifted automatically on its shaft so as to place the row of signs concerned above the printing surface of the paper ribbon. By acting on an ordinary key, on the other hand, the type-wheel is rotated as far as to bring the type in question in front of the paper, when the latter is pressed against the wheel and receives the printing, to return downward again simultaneously and to be removed as far as the interval of two letters, so as to be able to receive the following sign. This process will occur simultaneously in both of the apparatus connected by the line; *i. e.*, both in the transmitter and receiver, being automatic in the latter, no matter whether there is or is not somebody operating the receiving apparatus. In the case of the owner of the apparatus being absent, the telegram may be read on the paper ribbon on his return. The electric printing telegraph will thus give two perfectly similar records of the same telegram, one on the sending and the other on the receiving apparatus.

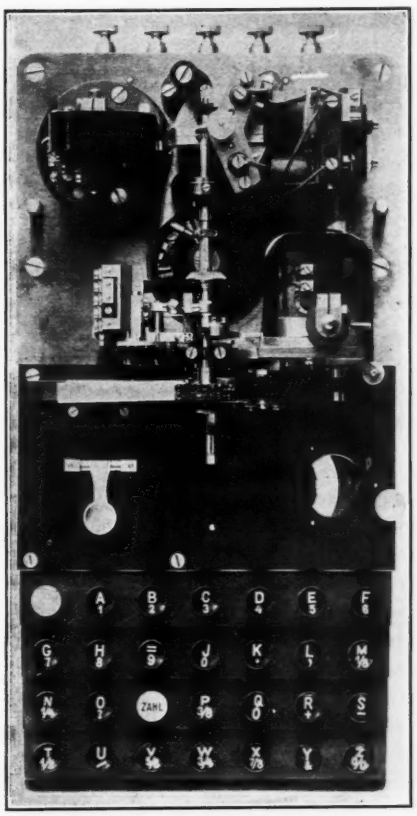


FIG. 2.—THE TELETYPER WITH COVER REMOVED.

As soon as the beginning key is pressed downward, the circuit of the transmitting apparatus is completed, resulting in a switching roller being set rotating, throwing electric currents of alternating directions into the printing telegram circuit and through the line relays connected to the apparatus; the latter will insert both in the transmitting and receiving apparatus local currents which by means of so-called relay magnets produce the rotation of the type-wheel from the initial

position identical in all the stations. Now, in the case of a letter key being pressed downward, a peg attached to the other end of its lever will strike against the rotating switching roller brush, stopping the latter and thus the type-wheel of the printing telegraph. At the same time the type levers of both apparatus being attracted will cause the corresponding letter to be printed. As long as the key is pressed downward, the type-wheels are incapable of moving any further, thus enabling the transmission to take place at any desired speed. After a telegram is transmitted, both the transmitter and receiver will be switched out automatically at a certain position of the type-wheel, the apparatus thus being stopped automatically. Twelve accumulator cells built into a box serves as a working battery. The tension of about twelve volts as obtaining in the line circuit is so low as to exclude any possibility of an inductive influence of printing-telegraph circuits on neighboring telephone circuits.

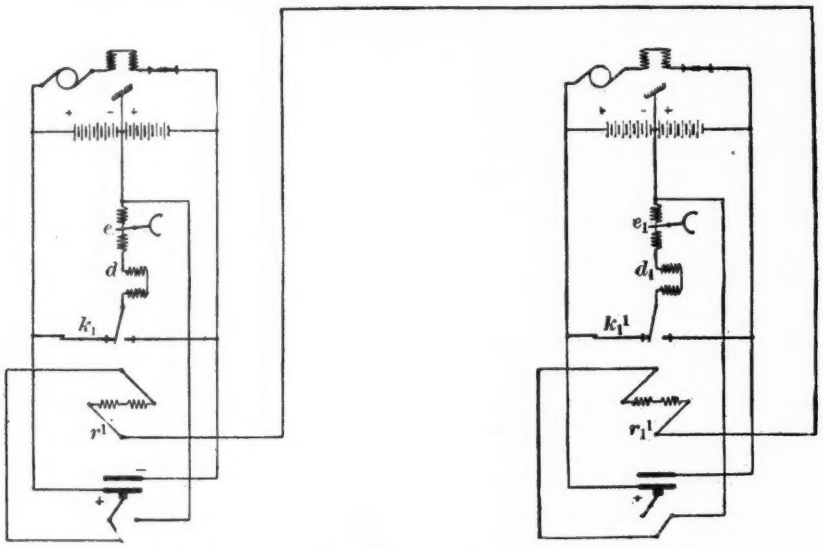


FIG. 3.—SCHEME OF CONNECTIONS OF APPARATUS, IN DIAGRAM.

The working of the apparatus is shown schematically in Fig. 3. In the receiving apparatus, shown to the right, the wire is led to the ground through the windings of the relay r^1. A current of rapidly alternating direction, traversing the line, will cause the tongue of this relay to move to and fro rapidly, the local circuit containing the pressure magnet *d*, and the polarized adjusting magnet *e*, being alternately applied to the outer poles of the two-pole battery. While the heavy pressure magnet is incapable of following the rapidly alternating currents traversing it, the adjusting magnet will move the armature of the escapement synchronically, allowing the type-wheel to proceed by steps. In the case of the alternating current of the line ceasing and a current being kept on for some time in one direction, both the adjusting magnet and the type-wheel being stopped, the pressure magnet will be allowed to attract its armature and to print a type. In the sending position, the line is applied to the battery through the inverted relay and a commutator, the brush of which is moved synchronically with the type-wheel, when the battery current traversing both relays will invert their tongues, the adjusting magnets allowing the type-wheels to proceed one step and the brushes of the commutator being adjusted for the subsequent contact. The direction of the current in the line will thus be inverted, the tongues of the relay returning backward, and so on, the type-wheels running synchronically until the brush on the commutator of the sending apparatus is arrested by a key pressed downward, when both apparatus being stopped will cause the type desired to be printed.

The mechanical arrangement is shown in Figs. 4 and 5, the electromotor shown at the right has a vertical axle stretching the spring 1. As soon as the force of this spring has assumed a certain magnitude, the vertical pressure of the worm-wheel *u* against the worm would be strong enough to lift the armature resting below on a lever, resulting in the two carbon discs *t* being removed from one another in a direction practically parallel to the tangent in their point of contact. The motor current will thus be interrupted, to be completed again as soon as the tension of the spring has been lessened by its unwinding. The two carbon discs are provided with click springs, so as to turn continuously while the contact is working, the places brought into contact being renewed continually. In the middle of the axis the conical wheel *m* is arranged, engaging with a similar wheel *n* (Fig. 5). To this wheel, the arm *p* being capable of being arrested by rods connected to the various keys, is connected through an elastic coupling, while the brush *o*, sliding over the commutator segments, is rigidly connected to *p*. A singularly shaped spiral is cut into a continuation of the conical wheel *m*; to this is applied an arm *q* being shifted to the left through the rotation of the shaft, moving at the same time toward the axis. In pressing down the beginning key, as well as in any movement of the pressure lever, the piece *g* is turned, the arm *q* thus being allowed to apply itself to the upper part of the spiral.

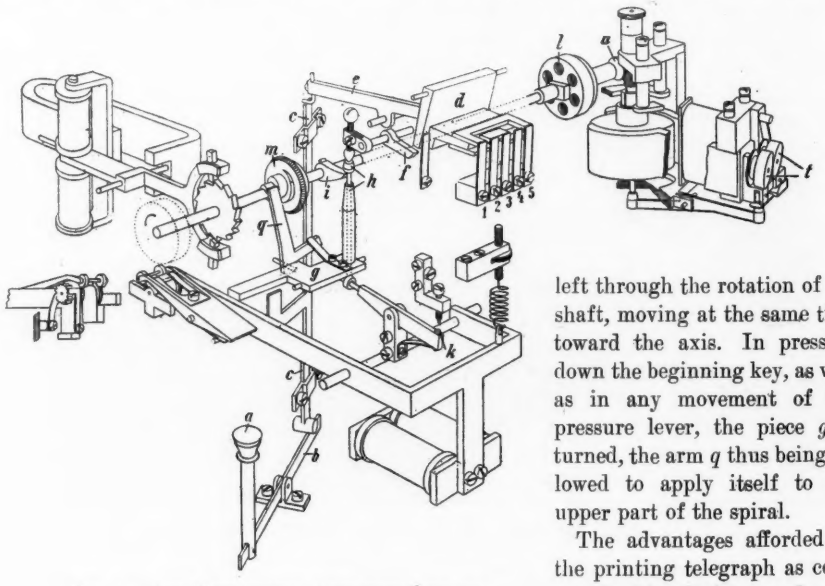


FIG. 4 —THE MECHANICAL ARRANGEMENTS OF TELETYPER.

The advantages afforded by the printing telegraph as compared with telephone and present telegraph systems will be evident. Like the telephone, the printing telegraph may serve for a direct communication between two persons over any distance, but has the additional advantage of any hearing mistakes or other misunderstandings being excluded by the

double and simultaneous reproduction of the communication in printing. As above stated, the printing telegraph will at the same time make it impossible for a third person to overhear communications which is even possible in the case of the Morse

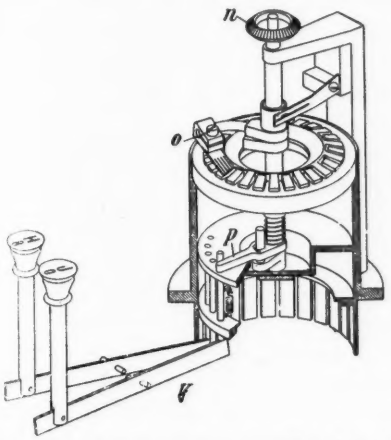


FIG. 5.—THE COMMUTATOR AND KEY ACTION.

telegraph. This is, therefore, the only means of communication enabling despatches to be kept strictly private.

The central station (Fig. 6) just opened is fitted with a switchboard having indicators and catches for one hundred subscribers. Sixteen connecting strings allow of thirty-two subscribers being simultaneously connected, so as to enable a simultaneous communication between a third subscriber in question dropping and an alarm being rung, when he will put himself in communication with the caller, in order to ask for the desired connection and connect both subscribers so that their apparatus are ready for direct communication. This shows the similarity of service with telephone service and the great advantage of any two subscribers communicating directly. There is, however, in addition, the possibility of connecting any desired number of subscribers to the same printing telegraph so as to transmit the same communication simultaneously to all the subscribers.

Similar telegraphic services from one central station to a certain number of subscribers simultaneously by a so-called "ticker" have for some time been in use in New York, London and Paris. A similar service has been in operation also in Bremerhaven, Germany, for transmitting ship telegrams from one central station to one hundred subscribers in different places. The central station just opened in Berlin is also intended in addition to mutual communication between the subscribers, to transmit similar informations to a certain number of subscribers, limiting the service at first to exchange telegrams. The same system of communication could be employed for transmitting telegrams from a central telegraph office, such as Reuter's, to a certain number of newspaper offices. In addition, the above central is intended to secure communication with the central telegraph office for

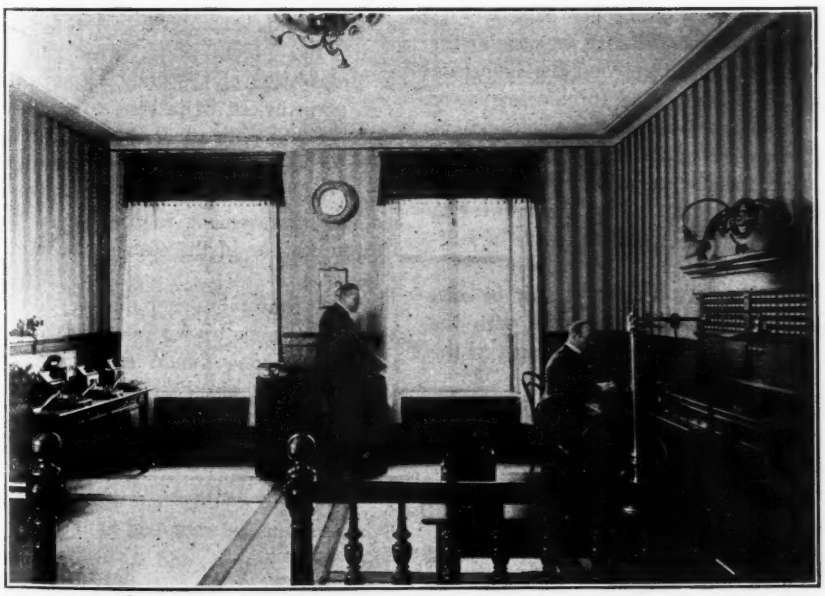


FIG. 6.—THE BERLIN TELETYPING CENTRAL STATION IN OPERATION.

of all the subscribers in the case of the switchboard being complete. As soon as a subscriber presses down the calling key of his teletyper, the official in charge of the indicator board of the central station will be advised by the indicator of the transmitting or receiving telegrams through the state telegraph. The new system has been in use for some time with great industrial concerns, such as the Berlin Allgemeine Elektricitäts-Gesellschaft and the Siemens & Halske for communication between their various departments.

THE RATED SPEED OF ELECTRIC MOTORS AS AFFECTING THE TYPE TO BE EMPLOYED.[1]

BY H. M. HOBART.

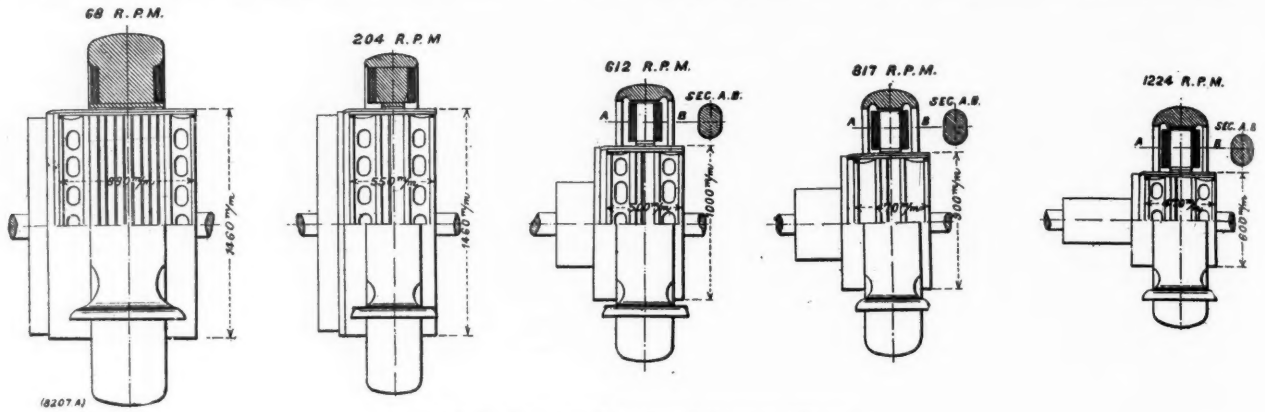
High speed is an unfavorable condition for the continuous-current motor, but, up to certain limits, conduces to improved results for induction motors. Of course, the required speed can rarely be the determining factor in the choice between these two classes of motors; but it is well that the extent of the influence of the speed should be realized.

Now it is most difficult to make consistent assumptions as the basis for a number of comparative designs, but I have taken for a set of continuous-current designs, for a 150-horse-power shunt motor, five speeds ranging from sixty-eight revolutions per minute to 1,224 revolutions per minute, and, without figuring out the details with any elaboration, have, nevertheless, endeavored to proceed on fairly reasonable lines. I have followed this same policy with two groups of induction motors, the first group being for twenty-one-cycle motors ranging from thirty-six poles and sixty-eight revolutions per minute to four poles and 612 revolutions per minute, and the second group being for sixty-three-cycle motors and ranging from twelve poles and 612 revolutions per minute to six poles and 1,224 revolutions per minute. Although I should have preferred to concentrate attention upon the influence of the speed, and not to enter upon the question of the influence of the periodicity, the extreme range of speeds which I wished to cover made this impracticable. Thirty-six poles is already abnormal enough for a 150 horse-power induction motor, and yet this leads to a group of three motors, the last of which, at 630 revolutions per minute, has but four poles, thus requiring stepping up to a higher periodicity for a higher speed design.

The general design of these eleven motors and some of their leading constants are set forth in Figs. 1 to 11. In Fig. 12 are shown curves roughly indicative of the relative factory costs of these eleven designs for the three groups. These costs have been derived from the product of diameter D, of rotor in centimetres and length L, over armature winding in centimetres—*i. e.*, from $D \times L$ for the continuous-current machines. The windings of induction motors being less definite as to overall length, L has been taken equal to the gross core length λ_g plus seven-tenths of the air-gap pitch τ—*i. e.*, L

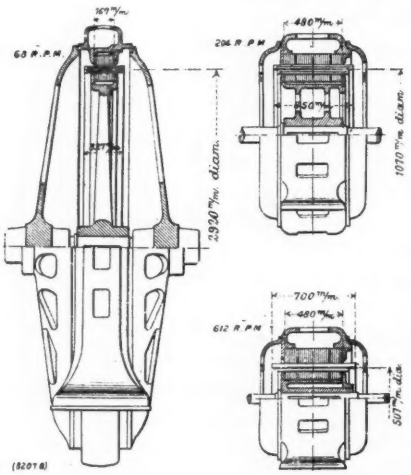
[1] Paper read before the British Institution of Electrical Engineers on March 10, 1904—Abridged.

$= \lambda_g + 0.7\ \tau$ for the induction motors. D × L has been found to be fairly proportional to the total factory cost for continuous-current dynamo-electric machines, for a given voltage and for so-called "barrel"-wound armatures. The same expression has also been found fairly proportional to the total factory cost for induction motors.



FIGS. 1, 2, 3, 4 AND 5.—CONTINUOUS-CURRENT MOTORS.

The total factory cost may thus be set equal to $K_c \times D \times L$ for continuous-current motors, and to $K_i \times D \times L$ for induction motors, where K and K_i are constants for any one firm. The ratio of K_c to K_i which we may denote by R $\left(R = \frac{K_c}{K_i}\right)$, has been found to vary greatly with different manufacturers. From a study of the data kindly supplied to me for the purpose by four manufacturers, it is believed that 1.5 is a fair value to take for R for the purposes for which it is required in this paper. Thus, for motors having equal rotor dimensions, the continuous-current motor will be taken as costing fifty per cent more than the induction motor. This, however, would not be the ratio of cost for the same output, because different diameters and lengths would be taken in the two cases. As a rough value for the total factory cost of continuous-current motors 1.00 shilling per D × L may be taken (although this varies considerably with different manufacturers), D and L being expressed in centimetres. Hence 0.67 shilling per D × L will be the corresponding total factory cost for induction motors. This would rise to 0.75 shilling per D × L for motors with wound rotors, and would fall to 0.60 shilling per D × L for motors with squirrel-cage rotors.[1] At low speeds the diameter would be much greater in the case of induction motors. At high speeds, and especially at low periodicities, the reverse would be the case. This is shown in Fig. 14. In the upper part of Fig. 15 are given the full-load efficiencies for the continuous-current and the induction motors. Whereas the former are lower for the higher speeds, the efficiencies of the induction motors rise fairly rapidly, starting from a very low value for the lowest speeds. In the lower part of Fig. 15 are given corresponding curves of half-load efficiencies.



FIGS. 6, 7 AND 8.—TWENTY-ONE-CYCLE INDUCTION MOTORS.

From Figs. 16 and 17 it may be seen how the power-factor improves with the speed, and how the no-load current at the same time decreases.

Fig. 18 shows the increase in reactance voltage at full load for increasing rated speed. As is evident, the results are very unfavorable for the higher speeds, whereas they are decidedly favorable for the lower speeds.

The peripheral speed of the commutator in metres per second is shown in Fig. 19. Where special, and as yet not thoroughly proven, methods of commutation are not resorted to, these high commutator speeds must be employed for high-speed designs of continuous-current dynamos.

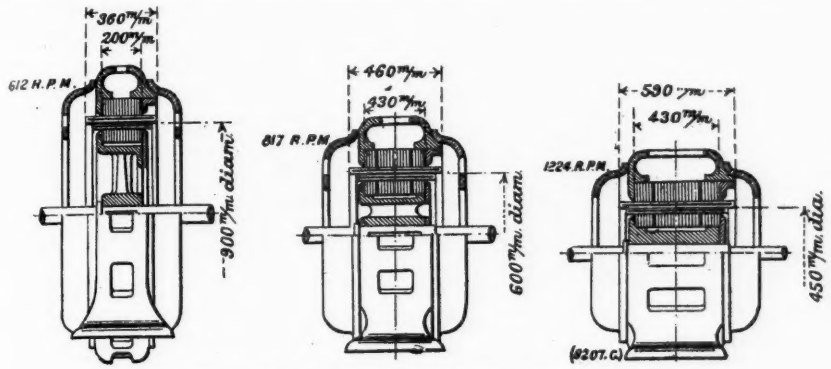
It is thus evident that with increasing speed, while all the properties of the induction motor improves markedly, the reverse is the case for the continuous-current motor, and one would be inclined to believe that this points out the best field for these respective types, and that the influence of the speed should be taken into consideration when other circumstances permit.

Although, as has already been stated, the demonstration of the influence upon the results (very favorable for induction motors, and exceedingly unfavorable for continuous-current motors) of increase in the rated speed does not, owing to the preponderating extent of this influence, require the exercise of any great care in the preparation of the designs compared, it is, nevertheless, of interest to set these forth in some detail. A more careful study of each of the individual designs might easily lead to a considerable percentage improvement in the results for a given cost, or in the cost of the results obtained.

Where continuous-current and induction motors come up for comparison, it is natural that one should seek for some common ground as a basis for the designs. It has seemed to me that the most significant common attribute for this purpose is the ratio $\frac{\lambda}{\tau}$ in which λ equals the length of laminations between end flanges (λ_g = gross core length and λ_n = net core length) end τ = polar pitch at the air-gap—*i. e.*, the circumference at the air-gap divided by the number of poles. As already described, the cost of the induction motors has been taken proportional to $D \times (\lambda_g + 0.7\ \tau)$, and the cost of the continuous-current motors to D × L, where L = length over end connections. In general, for continuous-current motors

[1] This paper does not concern itself with absolute costs. The comparisons are purely relative. Nevertheless, it serves to fix ideas to employ some unit of value, and the equivalent chosen has been shown to apply approximately in an article published in No. 40 of the *Electrotechnische Zeitschrift* for 1908.

L is also approximately equal to $\lambda_g + 0.7\,\tau$, although in the case of well-defined windings having the end connections lying in extensions of the armature core's external cylindrical surface, it is more instructive to use the expression D × L as the basis for cost estimates and comparisons.



FIGS. 9, 10 AND 11.—SIXTY-THREE-CYCLE INDUCTION MOTORS.

$\frac{\lambda}{\tau}$ is again useful in obtaining the value of C in Behrend's formula for the leakage factor σ, which is —

$$\sigma = C\,\frac{\Delta}{\tau},$$

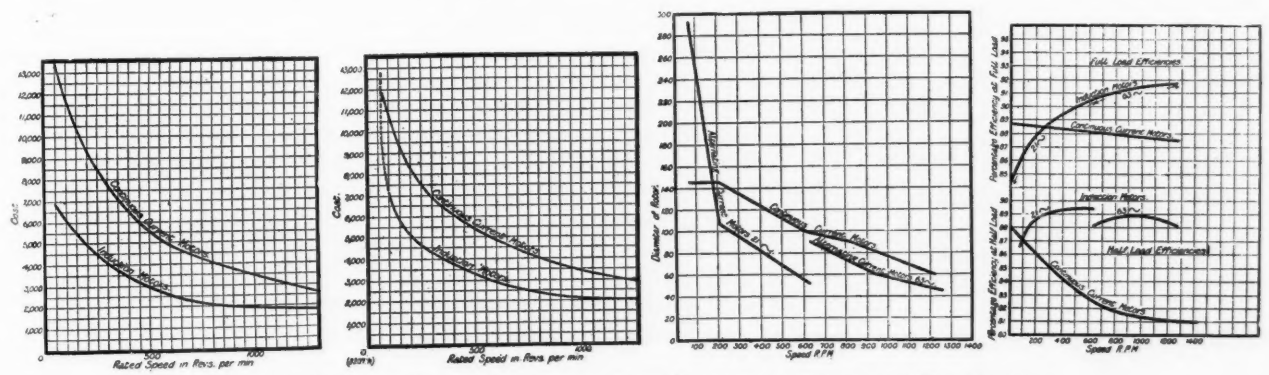
Δ being the radial depth of the air-gap.

The writer obtains the value for C from curves showing it as a function of the ratio $\frac{\lambda}{\tau}$ and finds that this leads to results rather more accurate than are otherwise obtainable from Behrend's formula, and far more conveniently arrived at than by means of the more complex formulæ sometimes employed for the estimation of σ.

In the case of the induction motors the radial depth of the air-gap has been taken at 0.18 centimetre for all cases. This is not in accordance with practice. A lesser gap with the corresponding electromagnetic advantages would be employed by most designers for the higher speed designs. But to avoid entering into the discussion of the most suitable respective values, I have adhered throughout to the value of 0.18 centimetre, and the induction motors come out so greatly superior to the continuous-current motors at high speeds that they are well able to stand this handicap.

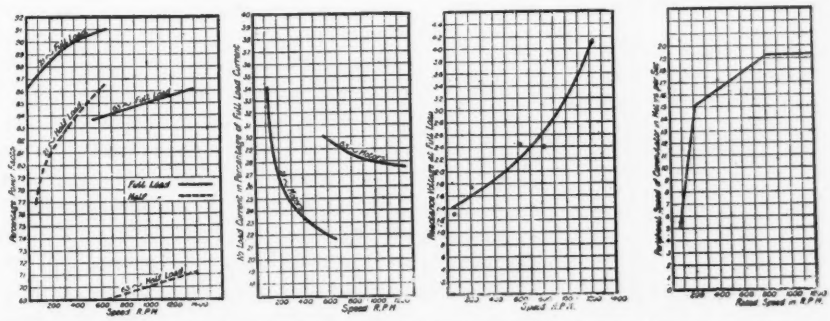
For a moderate range of speeds for the same output, say, a range of 1 to 4, I should have taken the same number of poles and the same diameter for all my continuous-current designs, as I find this to be a practicable and correct designing principle for this class of machinery. Here, however, with a speed range of 1 to 18, the lower speed designs are given more poles and larger diameter, and *vice versa* for the higher speed designs. The range of diameters is, however, far less than is customary with most designers, and this is a point of interest, since, although I do not claim to have devoted to each design more than enough attention to ensure a sound demonstration of the main proposition, it nevertheless appears that, in this respect, the designs are about right for the required conditions.

It is interesting to derive the costs by another and independent method, which consists in determining the cost of the effective material on the one hand and of the non-effective material independently on the other. The latter component can be derived if a sufficient number of machines of the same diameter, but of variable length, are plotted, with the cost of the non-effective material as ordinates, and the effective length l as abscissæ. By these means a curve can be obtained which, if produced, intersects the axis of ordinates at a point giving the cost of non-effective material for zero effective length of armature.



FIGS. 12, 13, 14 AND 15.—CURVES SHOWING COSTS, DIAMETER OF ROTORS AND EFFICIENCIES.

This has been investigated by the author, as described in *Electrotechnische Zeitschrift*, No. 40, 1903, and it has been found that the cost of the non-effective material for zero net length of armature core equals approximately $\frac{D_1^2}{10}$ shillings, if D_1 denotes the external diameter of the yoke in centimetres. Such a curve also shows the increase in the cost of the



FIGS. 16, 17, 18 AND 19.—CURVES SHOWING EFFECT OF SPEED UPON CHARACTERISTICS.

non-effective material in dependency upon the net length of the armature core, and taking into account the influence of the diameter, one could roughly set this increase as equal to $0.18\ D_1\ \lambda_n$.

The estimation of the costs by this method is carried out in table I, for the continuous-current motors.

TABLE I.—ESTIMATION OF TOTAL WORKS COST OF 150-HORSE-POWER CONTINUOUS-CURRENT MOTORS.

Diameter over all (D_1)...	225	212	165	154.6	124
Cost of non-effective material for zero length of armature core.....	5100	4500	2700	2400	1550
Increase in cost of non-effective material with increased length.....	1460	480	300	285	260
Cost of effective material	5360	2610	1535	1395	1075
Total works cost...	11920	7590	4535	4080	2885
Do. by D × L rule..	12900	8060	4880	4080	2820

The same method has been applied as shown in table II to the induction motors, $\frac{D_1^2}{15}$ shillings being taken as the cost of non-effective material for zero net length of armature core, and $0.12\ D_1\ \lambda_n$ being the increase in cost of non-effective material with increased length. It will be seen that a good agreement is obtained in all except the first case.

TABLE II.—ESTIMATION OF TOTAL WORKS COST OF 150-HORSE-POWER INDUCTION MOTORS.

Diameter over all (D_1).....	364	164	116	146	116	102
Cost of non-effective material for zero length of armature core.....	8900	1800	890	1420	900	700
Increase in cost of non-effective material with increased length.....	660	790	560	300	350	440
Cost of effective material...	2840	2320	1440	940	850	860
Total works cost.....	12400*	4910	2890	2660	2100	2000
Do by D × L rule.....	6700*	4850	2610	2200	1870	1820

The costs as obtained in tables I and II are plotted in the curves of Fig. 13, and it will be seen that the results lead to much the same conclusions as were arrived at by the D × L method and plotted in Fig. 12.

The principal conclusions arrived at in this paper are as follows:

1. Induction motors are, for all capacities, considerably cheaper than continuous-current motors of equivalent ratings.

2. The general performance and the mechanical construction of induction motors improve rapidly with increasing rated speeds.

3. The general performance and the mechanical construction of continuous-current motors improve rapidly with decreasing rated speeds.

4. The use of very low-speed induction motors and very high-speed continuous motors ought to be avoided whenever this is commercially practicable.

These conclusions are not new. They must, however, be much more widely understood if the electric transmission of power is to proceed on rational lines.

*This is an abnormal machine in every respect, but nevertheless closely follows lines of machines at present in operation. The D × L rule in so extreme a case gives far too low a value, and the value obtained by the analytical method is a trifle too high.

Contribution to the Discussion on High-Tension Transmission.

At the recent meeting of the American Institute of Electrical Engineers, at which several high-tension devices were discussed, no time was available for reading the written communications, of which a number had been received. The subjects for discussion were: "The Relative Fire Risk of Oil and Air-Blast Transformers;" "The Use of Group Switches for High Power Plants;" "Oil Switches for High Pressures;" and "Terminals and Bushings for High-Pressure Transformers." The following will give the new points of view which were brought out in these communications.

Mr. H. W. Tobey, Pittsfield, Mass., says that one defect of oil-insulated transformers is that the cases have been made too light, and, as a consequence, oil leakage has taken place, with a resulting risk of fire. Another fault is the use of a poor grade of oil. The ability of oil-insulated water-cooled transformers to withstand fires was demonstrated by the case of a fire which burned for three-quarters of an hour in a room where there were a number of 840-kilowatt transformers of this type. At the end of this time a pipe line above the power plant was opened, and the place was deluged with water for over eight hours. Upon inspection afterward, four of the transformers, which were a little further from the fire than the others, were put back into service immediately without repair. Others required drying by means of a current for a few hours, as well as filling with new oil. Four of the transformers were damaged and required repairing. In these the porcelain insulators had been entirely destroyed and the covers of the case were badly cracked.

Mr. W. J. Hazard, Golden, Col., advises filling the space above the oil of the transformer case with an inert gas, such as carbon dioxide, supplied from a generator which will automatically maintain a slight pressure in the transformer case. The extra complication and the cost of maintenance would be insignificant.

Mr. E. P. Roberts, of Cleveland, Ohio, has adopted the practice of installing transformers in fireproof rooms, and believes that the fire risk justifies the additional expense. This practice has been followed in the design of the Dayton & Northern power-house. The transformers are placed in a separate room built out from the power-house, with a firedoor between this room and the engine room. At the substation of this road the transformer room is shut off from the main room by a firewall. In these rooms the high-voltage lightning arresters and switches have been placed. In a later design adopted for the Dayton & Muncie Traction Company, the transformers are placed in a two-story addition to the main building. The upper story contains the switches and lightning arresters, and is on a level with the engine-room floor. In the basement the transformers are located. This room is drained so that if the oil runs out it should be carried off; but, in any case, it can not run into the power-house.

Mr. Howard Bayne, New York city, calls attention to the effectiveness of steam in extinguishing oil fires. Transformers should be placed in a separate vault, and in case of a large number of units, the vault may be subdivided. Into each vault one or more two-inch steam pipes should be let. In case of fire, all outlets should be closed and steam turned on.

Mr. W. L. Waters, of Milwaukee, Wis., believes that an air-blast transformer is at the mercy of almost every fire, no matter how started, and it will almost be seriously damaged itself, though it may not add much to the conflagration. On the other hand, an oil-cooled transformer is in practically no danger, except in a large fire, but then the risk is serious. Generally a set of oil-insulated transformers will be a much safer installation than a corresponding set of air-blast transformers.

A different view is held by Mr. Irving A. Taylor, Brooklyn, N. Y., who believes that the oil-insulated type of transformer is a greater fire risk than the air-blast. To reduce the risk of fire starting from inside, the oil in the case must be maintained well above the level of the coils. If transformers are sealed air-tight, a short-circuit may produce a sufficient explosion to blow the cover off or crack the case, allowing the oil to run out. The cover should, therefore, not be air-tight, but should prevent a circulation of the air. One of the greatest dangers from the oil-insulated type is caused by leakage of oil. For this reason, this type of transformer should, wherever possible, be installed in a separate building, thoroughly fireproofed, which is used exclusively for that purpose. When air-blast transformers are used, no inflammable material should be placed near them. The wiring should be lead cables enclosed in tile up to the transformer. Where rubber is used, it must be thoroughly fireproofed.

Professor D. C. Jackson, of Madison, Wis., discussing the use of group switches,

believes that the most reliable service is secured by bringing directly to the main bus-bars all of the generator and feeder circuits. Each circuit should be supplied with a master switch by which it can be disconnected independently of its two selector switches. With such an arrangement no local accident which may occur beyond the main bus-bars can interfere with more than one circuit. With the group-switch arrangement, the reliability of service is not so great, since auxiliary bus-bars are introduced, an accident to which will disturb the operation of all the circuits in the group. A group-switch system is not necessary to give simultaneous disconnecting or transferring of circuits, as master control can readily be arranged for operating the switches of two or more circuits simultaneously.

Relative to the same topic, Mr. Irving A. Taylor believes that there are few plants, even of great magnitude, where a complete shutdown for five minutes—long enough to clear a defective switch—once a year or two, is of sufficient importance to warrant the expenditure of several thousand dollars to prevent it. Probably large lighting companies having a low-tension network are an exception to this, on account of the difficulty of starting up after a shutdown. He advises the use of an air switch connected in series with each feeder or generator oil switch, since the oil switch may be defective without its being apparent, with consequent danger to the employés.

Mr. Gilbert Wright, Pittsfield, Mass., suggests that in place of the arrangement of group switches and selector switches and bus-bars suggested by Mr. Stillwell, one set of main buses be used, instead of two, and that the feeders be tapped directly from this one, the feeders to be controlled electrically, singly and in groups. This reduces the total number of switches for the case considered by thirty-two, eliminates one set of main buses, eight sets of group buses, and the necessary wiring between the switches and buses. While the use of group switches and duplicate bus-bars is in the nature of insurance on the continuous operation of the plant, this insurance, placed in small amounts in a great many places, costs too much in proportion to the results obtained. He suggests for general station practice the use of as few switches, buses, and as little wiring as possible. Switches should be made larger and more rugged, with capacity to handle not once, but many times, the maximum load that they may be called upon, under any conditions of service, to handle.

Mr. John B. Taylor, Schenectady, N. Y., believes that no hard-and-fast rule covering the use of group switches is advisable. The need of two switches in series for all circuits must be largely a matter of personal opinion. Where it is necessary to reduce the load on the station rapidly, this can be done by bringing to a central point the wires which control the opening of the voltage switches, so that a single motion of a gang switch will open simultaneously all the switches in that gang. While the group switch facilitates the transfer of feeders from one bus to another, Mr. Taylor thinks that, in general, a single set of bus-bars, properly installed, is all that is necessary. With few exceptions, the spare bus-bar is used only to allow men to work safely on or near the regular bar. In general, external feeder circuits can not be arranged in groups bearing a fixed relation to the generator units, and in such a case a group switch is likely to be of very little benefit. Commenting upon Mr. Stillwell's argument against the use of the group switch, as being additional apparatus which may itself increase the risk of interruption of service and the cost of installation and maintenance, Mr. Taylor thinks it is better to err on the side of simplicity and to give the reduced amount of apparatus rigid inspection and attention, than to go to the other extreme of constructing a cumbersome switch arrangement which is flexible only in theory, and confuses the operators in times of emergency. Mr. Stillwell's wiring diagrams were criticised for not providing sectionalizing switches for the buses, and a plan is submitted which consists essentially of a single main bus and a series of group buses which may be interconnected to form a reserve main bus in case of trouble, which will facilitate working upon the main bus. This arrangement retains the group switch, and also provides two switches in series between each generator and the bus. For the same number of generators in groups, as shown in the Manhattan diagram, sixteen less high-tension oil switches are required. Oil switches might be substituted for the knife switches connecting the different group bus-bars, but this is not thought necessary.

Mr. Irving A. Taylor, discussing Mr. Moody's paper on "Terminals and Bushings for High-Pressure Transformers," said that the terminals of air-blast transformers should not be located in the path of the blast, as they collect dust and offer a long creeping surface. For the same reason, terminal boards in air-blast transformers appear to be a source of danger. He has found that a porcelain tube through which a solid lead is carried to the transformer, the tube then being filled with sulphur, prevents oil from creeping out of the case. Stranded conductors or braided insulation should not be used. Transformer cases should be grounded to prevent fire and make them safe to handle. This grounding wire should be heavy in proportion to the circuit-protecting devices used. Where rubber-covered leads are employed, the rubber should be covered with fireproof material. Although taps allow one of the great advantages of the transformer to be utilized—that of obtaining different pressures from the same apparatus—often more taps are called for than are necessary. Taps cost money and are always a source of weakness. They should be avoided unless their use is absolutely justified. Except where transformers are to be used partly as pressure regulators, one five or ten per cent tap should give sufficient adjustment of ratio to meet lighting or railway conditions.

Mr. N. M. Snyder, St. Louis, Mo., believes that the design of high-tension insulators may be followed with benefit for meeting the conditions required in transformer construction. It should not be necessary to resort to oil-filled tubes for high-pressure terminals. A drawing was submitted of an insulator suitable for this work, this having a double petticoat, giving a path of much greater resistance than a straight bushing. Where heavy currents must pass through the transformer case, it is advisable to subdivide the terminals. This subdivides the load on the transformer more evenly, and gives better terminal surface for cooling.

The Engineering Press Monthly Index Review.

Beginning with the April issue, the title of the *Index of the Technical Press* will be changed to the *Engineering Press Monthly Index Review*. This change is being made in order that important modifications in the publication may be carried out. The size will be nearly doubled, and in addition to the 2,000 résumés appearing monthly, a review of the important engineering questions of the month will be given, as well as extended notices and summaries of the most remarkable articles and papers, appropriately illustrated. It is intended to make the publication a review of reviews of the engineering press.

Electrical Notes from Europe.

By Our Special Correspondent.

ONE of the most original features of the new No. 3 section of the Paris Metropolitan is the immense block of beton which has been sunk under the Place de l'Opera to form the crossing point of three tunnels. These belong to the new sections which are now underway, and the No. 3 will be the first to be completed. This forms a kind of three-story underground structure. The tunnels are pierced through the beton block (which is reenforced by a metallic construction) and lie one above the other. The lowest tunnel is at a considerable depth in the ground, while the roof of the upper tunnel lies near the pavement. The system of underground stations which are needed for the three lines, with their complicated arrangement of communicating passages and staircases, makes this an interesting point in the new Metropolitan lines. To mount the staircase from the lowest tunnel to the street is about the equivalent of going up a five-story building. Later on, elevators are to be installed. This part of the work has taken considerable time, as the beton block had to be laid in by compressed air caissons, but at present it is nearing completion, and the line No. 3 will soon be in running order.

A project for a narrow-gauge electric road has been lately submitted to the Swiss Government. It is to run between the towns of Brig and Gletsch, lying in the upper Rhone district. The line has 3,300 feet difference of level between the start and finish. The total length of the road is twenty-six miles. A gauge of one metre will be used. It is proposed to use monophase current for the motors. The trains will be made up of motor cars and trailers. A part of the line between Oberwald and Gletsch has a fifteen to twenty per cent grade, and here the rack-and-pinion system will be needed, using special locomotives for this purpose. The rest of the line will have the ordinary track.

According to the official report which has been recently published, the city of Brussels is equipped with three main generating stations, which supply current for lighting and power. The first of these stations is located on the Rue Melsens and has eight engines in all. Five of the engines give 500 horse-power each, and drive ten dynamos. The latter furnish 1,100 amperes at 130 volts. The remaining three engines are of larger size, and deliver 1,300 horse-power. Each is connected to a 260-volt dynamo of 2,600 amperes capacity. The station is equipped with a battery of accumulators of the Tudor pattern, which is connected in parallel with the machines. The battery can furnish 7,800 ampere-hours. The second station is situated in the Rue Louvain and uses six gas engines of 120 horse-power each. The engines are coupled to eight dynamos. Four of the latter deliver 125 volts and the remainder 250 volts, while the capacity of each is 310 amperes. A Julien battery is used in this station. It has a capacity of 2,800 ampere-hours. Current is delivered to the station from plant No. 1. At the latter point there is a battery of three transformers of 375 kilowatts, which deliver three-phase current at 5,000 volts to the line running from No. 1 to No. 2. At the receiving station a similar set of transformers is used to lower the voltage. The third Brussels station is located on the Rue de la Vanne and also uses gas engines, being supplied with five units of sixty horse-power each. The engines drive seven dynamos. Four of these machines run at 130 volts and two at 260 volts. The capacity of each is 130 amperes. The remaining gas engine is coupled to a dynamo of 250 volts and 310 amperes. The station uses a battery of Julien cells giving 3,800 ampere-hours.

The experiments which have been lately made by Professor Lombardi, an eminent Italian scientist, bring out some new points relating to the osmium lamp. He made a series of tests to compare the osmium with the carbon filament under different conditions. For the same brilliancy it is found that the osmium filament burns at a lower temperature than the carbon. Where the latter works at 1,565 to 1,580 degrees centigrade, the osmium filament has a temperature of 1,485, which is 135 degrees less. The high efficiency is another point which has been already recognized in the case of the osmium filament. Professor Lombardi finds that it takes much less energy than the carbon filament and shows that the difference is due to the fact that the osmium has a higher emissive power than the carbon filament. In the experiments he finds it to be one and one-half times that of carbon. Professor Weber, who is an authority upon lamp filaments, has already shown that the relation of the luminous intensity to the power taken by the lamp is a constant for carbon filaments. But in the case of osmium, Professor Lombardi finds that the value of this ratio becomes less as the power increases. One of the principal tests was made upon an osmium lamp of twenty-five candle-power, working normally at forty volts. Two of the most interesting points in the curve, lying near the normal candle-power, may be noted here. With the lamp burning at 35.2 volts and taking 0.840 ampere or 29.6 watts, the candle-power is 17.06, making 1.74 watts per candle-power. When the lamp is worked at 43.5 volts, 0.962 ampere and 41.8 watts, it gives 39.3 candle-power and consumes but 1.06 watts per candle-power. The high efficiency of the osmium filament as compared with carbon will be observed. In the latter case the temperature of the osmium filament is 1,457 degrees centigrade. When pushed to 51.2 volts, the lamp takes 0.74 watt per candle, while the temperature rises to 1,514 degrees.

A new lamp filament of special composition has been brought out by Dr. Just, of Vienna, who lately presented a number of lamps before the Electrochemical Society, of that city. It seems that the new filament contains boron and is made by a new process, the details of which have not as yet been made public. It is claimed that it can be turned out as easily as the carbon filament. One point in favor of the new lamp is that it works at a much higher efficiency than the carbon filament. A lamp was shown which burned on 110 volts and gave thirty candle-power. It takes but 1.7 watts per candle, which makes its efficiency about twice that of the carbon filament.

An electrochemical exposition is to be held at Warsaw this year, lasting from June to September, and a considerable surface will be devoted to the exhibits. A large building is in erection for the dynamo plant, which is to be one of the main features. The exhibits are divided into two sections. First, engines, boilers, turbines and different sources of motive power. Second, the electrochemical sec-

tion: (1) Construction of dynamos. (2) Power transmission. (3) Lighting. (4) Telegraphs and telephones. (5) Electric signaling. (6) Electromedical applications. (7) Metallurgy and galvanoplasty. Information can be obtained from the director of the exposition, 5 Rue Moniuzko, Warsaw.

Professor Becquerel has been giving a series of lectures upon the subject of phosphorescence and the new radioactive bodies at the University of Paris, which are quite *apropos* at this time, seeing the great interest which is being taken in the question of radium and similar bodies, and no one is better qualified to treat this subject than M. Becquerel, seeing that he was the first to discover the rays which are given off by uranium and which radium now produces in much greater quantity. Among the interesting features are the crystals of uranium salt which were used in the first experiments, and the original photographic impressions obtained with the new rays are shown projected on the screen. M. Currie loaned a tube containing the largest quantity of radium salt which has yet been produced; the tube contains four grammes, and as the expense of producing the salt is said to be $30,000 per gramme, it will be seen that the specimen is of great value from every point of view. The tube which is not more than one and one-half inches long and a quarter of an inch in diameter, is carried on the end of a flexible wire which is fused into it, in order to avoid placing the hand in contact with it, seeing that the radium attacks the tissues. In the dark, the tube is luminous, but the effect is greatly heightened by placing near it a fluorescent screen of platinocyanide of barium, or a uranium crystal, when these become highly luminous, the latter with a brilliant green light. The four grammes of material in the tube come from the treatment of 80,000 pounds of residues.

According to recent reports a new process has been brought out for obtaining metallic calcium, which is to furnish an abundant and cheap supply of this metal. Heretofore it has been very difficult to produce it and the price is high in consequence, but Professor Borchers, aided by M. Stockem, of the Electrometallurgical Institute of Aix-la-Chapelle, succeeds in reducing the metal in the electric furnace. Chloride of calcium is used, and, as it melts at 800 degrees centigrade, the reduction is carried out with but little trouble. The nature of the electrodes forms one of the main features of the process, and it was only after considerable work that the proper form was obtained. The method is somewhat analogous to the production of aluminum from bauxite as to the leading features. While the price of metallic calcium has been about $25 per pound, the inventors claim that it can be produced for an insignificant sum and even cheaper than aluminum. Should the process be successful on a commercial scale, the metal will find many uses in the chemical industries and in scientific work. Its properties as a reducing agent will enable it to replace sodium or potassium in many cases. It is less powerful than these two metals, but more so than aluminum or zinc. As calcium oxidizes rapidly in the air, it can not be used like aluminum for making different objects. If it can be produced cheaply it will no doubt come into extensive use in the metallurgy of iron, as it is found that it drives out the phosphorus, sulphur and oxygen from iron. Aluminum also has this property, and it has been recognized that this metal can be added to the iron in small quantities to expel the above bodies. In this case the resulting metal contains some aluminum and is therefore inferior to pure iron in quality, as regards breaking strain, etc., but the metal is still preferable to iron which contains sulphur or phosphorus. Should it be possible to add a small quantity of calcium to iron in order to drive out the impurities and at the same time not injure the quality of the metal, as has been supposed, this will be a new use for calcium and it may find an extensive application in the iron industry. Fresh information about the new process is therefore awaited with interest.

A project is on foot for running a double circuit telephone line between Berlin and St. Petersburg, passing by Eydtkuhnen and Koenigsberg. It is estimated that the cost of installing the Russian part of the line would be $400,000. As the city of Moscow is now connected with St. Petersburg by telephone, this will offer communication between Moscow and Berlin. Another project is to connect Warsaw with the German telephone system by a special line.

The electric equipment of the new German battleship Preussen, which has recently been launched, is carried out on the most improved plan, and current is applied to a great many different uses on board. Two main dynamo rooms furnish the current. Two of the direct-coupled generating sets use steam engines of 105 horse-power and the other two sixty-seven horse-power, with a battery of accumulators which acts as a reserve. Besides the very complete system of incandescent lamps the current is used for four projectors of high power. Motor-operated blowers are used extensively throughout the vessel. Electric elevators raise the supplies up to the guns, and the coal is handled in a like manner from the bunkers to the boiler room. The launches are put to sea by electric cranes. Motors are also used in the tourelles, as well as for the ice machines and in the repair and tool shop. An extensive system of electric signals for transmitting orders throughout the vessel has been installed by Siemens & Halske. The telephone arrangements are, of course, quite complete. The main electric outfit is furnished by the Siemens-Schuckert Company.

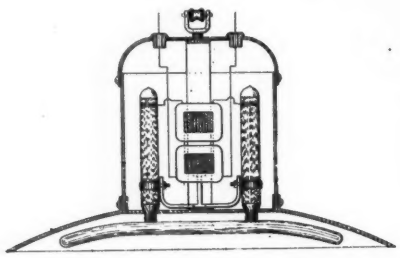
The government commission is studying the project for the new Rome-Naples line, in which electric express trains are to be used. According to the most recent information, it is proposed to run an entirely new double-track line at five miles from the coast, which will be much shorter than the existing railroad. There will be fifteen stations along the line, with a large terminal depot in the centre of each city. The commission has not as yet specified the system of traction which is to be used, but prefers that of the Valtalline lines or the new Marienfeld-Zossen system. It favors the use of independent motor cars with common control, such as the Thomson-Houston Company uses. A train would be made up of three motor cars, running at a speed of sixty miles an hour, and would require 1,500 horse-power. With six trains running on the road at once, 9,000 horse-power would be needed. It is expected to make use of the numerous falls in the region, and as much as 100,000 horse-power could be obtained. Of this amount, 25,000 horse-power could be sent over a high-tension line to be used at Naples. It is estimated that the electric outfit would cost over $3,000,000, while the entire system figures for $22,000,000.

C. L. DURAND.

Paris, March 26.

Electrical Patents.

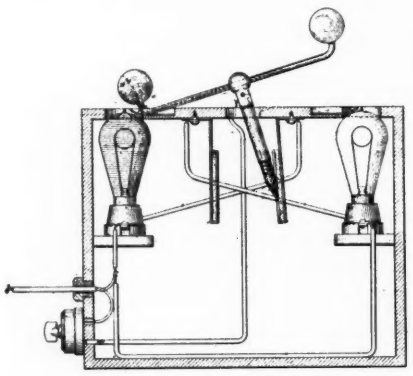
Mr. Daniel M. Moore, of Newark, N. J., is the inventor of an electric tube lamp, which comprises substantially a potential raising transformer, together with a suitable protective enclosure, all combined, so that the high-potential terminals of the transformer and the energy-transferring terminals of the



Electric Tube Lamp.

tube shall be enclosed in a suitable protective enclosure or casing out of danger of contact with external objects, while from the casing projects respectively the conductors which carry the low-tension energy to the primary of the transformer and the translucent, but harmless, portions of the tube supported by its ends and whose gaseous contents are rendered luminous by the high-potential energy from the transformer. In carrying out the invention a tube is employed, which is curved, and the body of which contains the gas furnishing the effective illuminating portion of the lamp. Preferably the curved portion lies practically in one general plane, while the ends of the tube project in a direction which may be described as transverse to the plane in which the major or illuminating portion of the tube is located. The ends are mounted and supported within the casing in any desired way. The metallic terminals of the tube when it is in place are located entirely within the suitable protective cabinet or casing and are in connection with the secondary terminals of a transformer of any desired character, which secondary terminals are also within the casing. The primary of the transformer has its terminals of comparatively low potential let out through the casing and connected with suitable supply wires. The transformer is properly supported by a frame or hanger in any suitable manner. The parts which support the tube consist of suitable clamps or yokes carried by brackets which are secured at the frame.

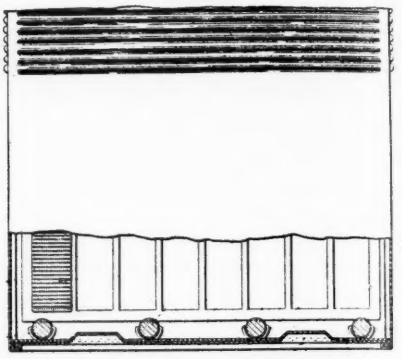
An automatic circuit-closer has been patented by Mr. James L. Russell, of Boston, Mass., which is especially applicable to illuminated signs or advertisements, and particularly to that class wherein lights, preferably differently colored, are intermittently flashed upon a transparency, but it will be useful wherever an automatically operated intermittent circuit-closer is desired. In accordance with the invention, a hollow walking beam is provided, preferably of glass and partly filled with a fluid. Cooperatively arranged with relation to the walking beam is one or more heaters, which by its or their action upon the contents of the walking beam operate to shift the fluid back and forth from one end of the walking beam to the other, and thereby oscillate the walking beam, constituting in effect a motor. To this beam is attached a suitable switch which is operated thereby and in the circuit controlled by the switch are the lamps that are automatically and intermittently thrown into and out of action. In the best form of the invention, the heaters are the lamps themselves, which are thus automatically and intermittently operated by the operation of the walking beam. Also these lamps are preferably arranged in a casing hav-



Automatic Circuit Closer.

ing a wall made transparent in whole or in part and bearing a sign, advertisement, or the like, so that the alternate operation of the two lamps will intermittently illuminate the transparent wall. The attractiveness of the apparatus may be enhanced by providing means to color the light of one lamp or set of lamps differently from that of the other.

A reversible galvanic battery has been invented by Mr. Thomas A. Edison, of Llewellyn Park, N. J., and the object is to provide improved insulators or separators for this purpose which shall be cheap, light and effective, and at the same time be absolutely unaffected by electrolytic action in alkaline solution. To this end the insulators are made of glass, preferably in the form of rods or tubes. The can or receptacle is preferably made of thin sheet steel carefully nickel-plated and with corrugated sides, so as to be very stiff and light, and inside of the can is inserted a lining of hard rubber or other insulating material, in order to insulate the electrodes from the sides. The elec-

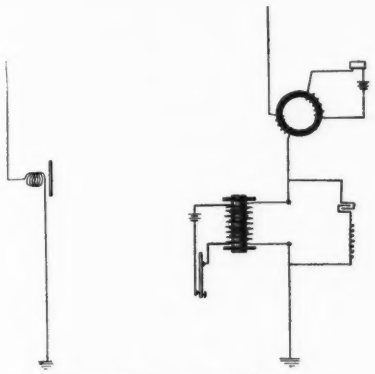


Reversible Galvanic Battery.

trodes are formed of plates, carrying sectional corrugated nickel-plated spring-steel pockets, containing the active material. The bottom of the can is provided with upstanding bosses which engage openings in the sheet-metal plate, also carefully nickel-plated, so as to be unaffected by electrolytic action. This plate rests on the bottom of the can. It is formed with ears, which engage glass rods or tubes very slightly above their centres, so as to hold the rods or tubes firmly in place without, however, offering any surfaces upon which any active material might lodge. The electrode plates are supported on the rods or tubes, and the latter are preferably formed with grooves into which the bottom edges of the plates are received, so that the plates are properly spaced at their lower ends and transverse movement is consequently prevented. In order to separate the plates mechanically and to insulate them electrically, a series of glass tubes is employed, which extends longitudinally of the plates within the spaces formed between the adjacent pockets. The separating rods preferably extend the entire length of the plates and rest at their bottom ends on the bottom plate.

An improvement in wireless signaling has been patented by Reginald A. Fessenden, of Manteo, N. C., and the patent obtained has been assigned to the National Electric Signaling Company, of Pittsburg, Pa. In carrying out the invention, a conductor is provided of suitable construction and arrangement, which is connected to the terminal of a coil surrounding a core, preferably annular in shape and formed of fine iron wire. The other terminal of the core is connected to one

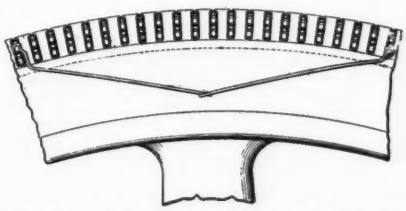
of the knobs or terminals of an induction coil or other suitable generator capable of producing practically continuous and rapid oscillation in the conductor. The other terminal of the generator is connected to the ground. A second coil, forming a part of the circuit for the battery, is placed on the core, and a transmitter, preferably microphonic in construction, is included in the circuit of the battery and coil. A capacity and inductance are connected in shunt to the spark-gap for the purpose of maintaining sus-



WIRELESS SIGNALING SYSTEM.

tained oscillations of practically constant frequency. The capacity and inductance should be arranged to have the same period of oscillation as the receiving conductor and the sending conductor. The circuit and the sending conductor are thus in parallel and not in series, consequently the difference of potentials across these two circuits is the same, while the currents in the two circuits are different. At the receiving station is a conductor, connected to one terminal of a mechanism capable of responding to oscillations in the conductor. A form of mechanism adapted to the purpose consists of a coil, having one terminal connected to the conductor and the other terminal grounded. A telephone diaphragm, formed of metal or consisting of insulating material having a metal plate or coil of wire secured to it, is supported in operative relation to the coil. The apparatus at the receiving station is made resonant by any suitable means. When an alternating current is set up in the conductor, such current acts to repel or attract the diaphragm, according to the time constant of the metal part of the diaphragm, through induced currents set up in the diaphragm. When the generator is operated the diaphragm will take up a mean position relative to the coil, the distance of such position from the coil varying with the intensity of the oscillations in the sending conductor; but when the current in the circuit of the other coil is modified, the permeability of the core is correspondingly changed or modified, thereby producing a corresponding change or modification in the self-inductance and a change in the frequency of the natural period of vibration of the sending conductor, which is thereby thrown out of resonance with a resonating circuit, connected in parallel to the sending circuit, and due to this failure in resonance producing a corresponding change or modification in the intensity of the waves or impulses given off by the conductor and in the intensity of the oscillations produced in the receiving conductor. The changes in the intensity of the oscillations will produce corresponding changes in the mean position of the diaphragm, such changes corresponding to the vibration of the diaphragm of the transmitter, exactly reproducing any of the waves or impulses which affected the transmitter.

An improved winding for electrical machines has been recently patented by Frederick J. Lindeman, of Pittsburg, Pa., and the patent obtained has been assigned to the Westinghouse Electric and Manufacturing Company, of the same place. In the present invention the rotating member of a machine, the core of which is provided with slots which may be either open, closed or partially closed



METHOD OF WINDING FOR ELECTRIC MACHINES.

at the periphery of the core and be of such dimensions as to receive the number and size of copper bars which will afford the service for which the machine is designed. Each slot contains two bars, the former of which projects a greater distance than the latter beyond the end of the core to accommodate end-connectors. The projecting end of each bar is provided with a slot and the projecting ends of the bars at the opposite end of the core are provided with similar slots. The outer portion of each slot is of less thickness than the inner portion. An end-connector is provided of any practical form, but preferably has its body portion of approximately V-shape in end elevation and embodies an offset at approximately its middle point, so that the two parts at the sides of this offset are in substantially parallel planes. The end of each of the parts is bent into substantially a rectangular hook, the length of which is substantially equal to the thickness of the bar to which it is to be connected and the ends of which are substantially at right angles to such portion in order to closely fit the edges of the bar. The location of the slot nearer to one side of the bar than the other ensures a large contact area between the end portions of the hook and bar. After placing the connector in position, the engaging parts may be soldered and any insulation applied which may be desired in addition to that with which the bars and end-connectors are provided before assembling.

Lehigh University Register.

The *Register* of Lehigh University, South Bethlehem, Pa., just issued, copies of which may be had on application, shows the attendance of 615 students from twenty-four states and ten foreign countries, of whom ninety are taking the course in electrical engineering. There are fifty-four in the teaching staff.

Thirteen four-year courses of instruction are offered at the University, the classical course, the Latin-scientific course, the courses in civil, mechanical, marine, metallurgical, mining, electrical and chemical engineering, analytical chemistry, geology, physics and electrometallurgy.

A list of graduates of the University, 1,304 in number during the thirty-eight years of its existence, indicates that this institution is exerting a marked influence on the industrial development of the United States, and also of foreign countries.

Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

The American School of Correspondence at the Armour Institute of Technology, Chicago, Ill.

Bulletin No. 2 issued by the American School of Correspondence at the Armour Institute of Technology gives an excellent description of the aims of this school and the method of conducting the work. The work of the school is divided among the departments of electrical engineering, mechanical engineering, steam engineering, civil engineering, sanitary engineering, architecture, textile manufacturing, drawing, mathematics and preparatory school. In each of these departments a number of courses are offered, each leading to some particular branch of applied science.

News from Mexico.

[*From Our Special Correspondent.*]

Electricity in all its applications in Mexico, together with developments and possibilities in that respect, forms one of the most important features of the nation's industrial progress.

Scarcely a day passes that application to the government for permission to construct electric plants, whether for power simply, traction or illumination, is not formally presented. In a country like Mexico, where cost of fuel for manufacturing or other purposes is enormous, seriously cutting into the profits of the miner or manufacturer, and in which magnificent waterfalls are to be found in every state, possessing latent power of incalculable capacity in the aggregate, going to waste, the revolution now proceeding can be readily understood.

The list of manufacturing and mining enterprises that have gone to the wall in Mexico during the past ten years, due largely to the heavy cost of fuel, is a lengthy one. Electricity is successfully solving the hitherto difficult problem, and where electrical forces are applied, prosperity as a rule follows in its train. Developments along this line, however, in Mexico, have but commenced. Progressive Mexicans all over the republic who lack the advantages of electricity, not to speak of Americans, who are here in plenty, are alive to the situation, and it is but a question of time when they too will utilize the wonderful current in the prosecution of their respective enterprises.

So plentiful are waterfalls in Mexico, that long-distance power is the exception, although of this latter there are several types, models of electrical engineering skill. Needless to say, American ingenuity, as well as capital, must receive credit for this.

An electric street car system will be inaugurated during the coming summer, connecting the city of Saltillo with Villa de Ortega. Address Senor Don Miguel Cárdenas, Saltillo, state of Coahuila. The state government has granted a concession for the undertaking.

An electric light plant will be constructed in the town of Real del Monte, state of Hidalgo. The state government is interested and has already subscribed a sum of money for the work. Address Senor Don Pedro L. Rodriquez, Pachuca, Hidalgo.

An electric plant will be built on the Oro river near the town of that name, state of Michoacan. The power will be used to operate machinery for mining and reduction purposes. A concession has been granted for the purpose named to Narcisco Sandoval, of Uruapan, Michoacan.

The John F. Kelly Engineering Company, Singer Building, Liberty street, New York, has charge of arrangements for awarding contracts for the construction of a large electric light plant on the Enchos river, state of Chihuahua. The project is to supply the cities of Parval and Chihuahua and other accessible mining districts with power.

An electric lighting plant will be constructed in Monclova, state of Coahuila, valued at $100,000 gold. The firm of Victor M. Braschi & Brothers, of this city, has the contract for the construction and equipment of the proposed plant.

The municipal authorities of Tacatlau, Jalisco, have decided to install an electric light plant and for that purpose have entered into a contract with an American company. Address Coronel Don Miguel Ahumada, Guadalajara, Jalisco.

A concession has been granted an American company by the state government of Colima for the installation of an electric light plant. The concessionaries have deposited a large sum as a guarantee to the fulfilment of the contract. Address Ugart & Garcia, Colima, Mexico.

The Mexican Tropical Planters' Company, with head offices in Boston, Mass., and large plantations in the state of Vera Cruz, will build an electric light plant for the purpose of illuminating its large sugar mill.

The Mexican Railway Company has applied to the government for permission to establish electric traction on the section of its road known as Las Cumbras de Maltrata, where the heavy grade requires two locomotives to haul an ordinary passenger train. The electric power will be generated at a large fall on the Atoyac river. The secretary for public communications and works has commissioned the government engineer to examine the falls and report the power it can produce. Address J. H. Muir, Orizaba, V. C.

An electric light plant will be constructed in the city of Campeche by the government of that state. Address Don Luis Garcia M. Campeche, state of Campeche.

The town of Cuautla, in the state of Morelos, will have an electric light plant, the power being generated from the river of that name. For the purpose named, a concession has been granted Senor Ignacio de la Toro y Mier, Cuautla, Morelos.

A concession has been granted Theodore V. Peeborn and associates to utilize 40,000 metres of water per second from the Janapa river near Cordoba in the state of Vera Cruz, to generate current for light and power, mainly for the cities of Cordoba and Orizaba. Address Mr. Peeborn, Orizaba, V. C.

Archbishop Gillow, of Puebla, has been granted exemption of duties and taxes for ten years for an electric light plant which he intends establishing in Chiantla, near Puebla.

The project for lighting by electricity the town of Sagos, state of Jalisco, is maturing. A concession has been asked for from the state government. Address Coronel Don Miguel Ahumada, Guadalajara, Jalisco.

The proposition to construct a broad-gauge electric railroad connecting the cities of Guadalajara, state of Jalisco, with Morelia, capital of Michoacan, has now assumed definite shape. The length of the new railroad will be 120 miles. Address C. F. de Lander, Morelia, Michoacan, Mexico.

The town of Puruándiro, Michoacan, will install an electric light plant. Address the Jafe Politico, Puruándiro, Michoacan.

The city of Tampico will be furnished with electric light by the firm of I. & F. Borde, of that city.

The American Mexico Mining and Development Company, of Chicago, with mines in the Velardeña and Reyes district, has contracted with the General Electric Company, of Chicago, for the erection of a $50,000 electric plant. Address the foregoing company, Torreón, Durango.

An American company contemplates purchasing the concession for the street cars of Hermosillo, paying for it the sum of $2,000,000 gold. This company intends to use electricity as motive power and to extend the lines to neighboring towns. Address Senor Don Rafael Izabal, Hermosillo, Sonora. J. B.

City of Mexico, April 1.

Complete Combustion of Coal.

United States Consul-General Richard Guenther, at Frankfort, Germany, reports on a new process for obtaining complete combustion of coal, which was described by Sir Joseph Primrose at a recent banquet at Glasgow. The invention consists in burning the coal in a chamber surrounded by a water-jacket separated from the boiler, so that the gases do not come into contact with the boiler until they have been burned completely. The inventor has experimented with this process, and believes that the new furnace will not only prevent smoke, but will enable a higher efficiency in the utilization of the heat of the coal to be obtained.

The International Electrical Congress.

The first meeting of the International Electrical Congress reception committee of the American Institute of Electrical Engineers was held at 12 West Thirty-first street, New York city, Thursday evening, March 24. The meeting was well attended, Mr. George G. Ward, local honorary secretary of the British Institution of Electrical Engineers, and members of the board of directors and of the transportation committee, who had been invited to attend, being present. An itinerary for the tour of the European visitors was offered by Chairman Lieb, and is given below. The details of this were thoroughly discussed, and it was suggested that arrangements be made permitting those who could not adhere strictly to this itinerary to return by alternative routes, or permitting them to spend a longer time at the exposition. It is understood that if these arrangements can be made with the railroad companies, the plan suggested will be adopted.

The following were appointed an executive committee: John W. Lieb, Jr., chairman; F. J. Sprague, vice-chairman; J. C. Barclay, J. J. Carty, F. W. Jones, H. Ward Leonard, E. H. Mullin, L. B. Stillwell, H. G. Stott, Calvert Townley, George G. Ward and J. G. White.

The following gentlemen were appointed chairmen of the local reception committees:

New York, T. C. Martin; Schenectady, E. W. Rice, Jr.; Montreal, Professor R. B. Owens; Niagara Falls, George W. Davenport; Chicago, Samuel Insull; St. Louis, Lieutenant W. V. N. Powelson; Pittsburg, Charles F. Scott; Washington, O. T. Crosby; Philadelphia, J. B. McCall; Boston, C. L. Edgar.

ITINERARY OF PROPOSED TOUR OF THE FOREIGN GUESTS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The foreign guests of the Institute, including the British Institution of Electrical Engineers, who are to be the official guests of the American Institute of Electrical Engineers, the representatives of the Associazione Elettrotecnica Italiana and representatives of other foreign technical bodies and unattached delegates, are expected to arrive in New York previous to September, 3, 1904. After this date the itinerary will be as follows:

SUNDAY, SEPTEMBER 4, New York city—This day will be spent in a steamer ride up the Hudson river, possibly as far as West Point, giving the visitors an opportunity of seeing the beauties of the Hudson river and the surroundings of New York city.

MONDAY, SEPTEMBER 5—The visitors will be entertained by the corporations representing the electrical industries of New York city, including a visit to the power-houses of the Rapid Transit Subway Company, the Manhattan Railway Company, the Metropolitan Street Railway Company, the New York Edison Company, the exchanges of the New York Telephone Company, and other points of engineering interest. In the evening there will be a formal reception to the foreign visitors under the auspices of the American Institute of Electrical Engineers.

TUESDAY, SEPTEMBER 6, Schenectady, N. Y.—The party will leave New York on Tuesday morning for Schenectady, where they will be received and entertained by the General Electric Company, leaving for Albany in the afternoon. Leave Albany in the evening for all-night trip to Montreal.

WEDNESDAY AND THURSDAY, SEPTEMBER 7 and 8—Reception at McGill University, Montreal, and visits to the important power transmission plants in the vicinity, leaving Montreal Thursday evening by boat or train for Niagara Falls.

FRIDAY, SEPTEMBER 9, Niagara Falls, N. Y.—Visit to the falls and the important power-houses and electrical industries of the locality. Leave Friday evening for Chicago, arriving Saturday morning.

SATURDAY, SEPTEMBER 10, Chicago, Ill.—Visits to important power-houses and local points of interest; leaving Saturday evening for St. Louis, traveling all night.

SUNDAY, SEPTEMBER 11, St. Louis, Mo.—To be spent in resting.

MONDAY, SEPTEMBER 12—Opening of the International Electrical Congress at 10 A. M., with joint sessions of all the sections.

WEDNESDAY, SEPTEMBER 14—Special joint session between the American Institute of Electrical Engineers and the British Institution of Electrical Engineers, to which all foreign guests are invited.

SEPTEMBER 13, 14, 15 AND 16—Sessions of the various sections of the congress with sessions each day from 9 to 12 A. M., and from 1.30 to 4.30 P. M.

SATURDAY AFTERNOON, SEPTEMBER 17—Closing general sessions of all sections of the International Electrical Congress. Leave for Pittsburg, arriving late Sunday afternoon.

MONDAY, SEPTEMBER 19, Pittsburg, Pa.—Reception and entertainment by the Westinghouse company, and visits to important and interesting local industries. Leave Pittsburg Monday night and arrive at Washington Tuesday morning.

TUESDAY, SEPTEMBER 20, Washington, D. C.—Inauguration of the National Bureau of Standards at Washington and visits to places of local interest.

WEDNESDAY, SEPTEMBER 21, Philadelphia, Pa.—Visits to important power-houses and points of interest. Leave for Boston in the afternoon, *via* boat.

THURSDAY, SEPTEMBER 22, Boston, Mass.—Visits to power-houses, Harvard University, Massachusetts Institute of Technology and places of local interest. Leave Boston at night for New York, by boat.

FRIDAY, SEPTEMBER 23—Unassigned.

SATURDAY, SEPTEMBER 24—Return home by some of the party.

Ladies are expected and special arrangements will be made to ensure their comfort.

Electric Tramways and Railways in Nice, France.

The annual report of Vice-Consul Attilio Piatto, at Nice, France, contains the following information relative to electric tramways and electric power in and near Nice. The communities on the lines of electric tramways which have been decided upon by the authorities are eager to have the work begun, but there seems to be little desire on the part of outsiders to take up the different concessions, while local elements are altogether lacking in the necessary initiative in such enterprises. There are several of these lines which would be good paying investments, if properly built and managed.

The project is being considered by a group of electrical financiers to build an electric power plant in the upper Roya valley. It is thought that this plan will enable power to be supplied to the city at prices much less than those now charged. This will permit the use of electrical apparatus to become more general.

British Street Railways.

The British Board of Trade returns, as reported by United States Consul Frank W. Mahin, Nottingham, England, show that there are 296 tramway undertakings in the United Kingdom, which have cost $200,000,000. These have nearly all been created in the past twenty-five years. Of the total number 142 are owned by municipalities and 154 by private companies. The municipal undertakings, though less in number, have more mileage and cost about $120,000,000; the private, over $80,000,000. The total length of both is over 1,700 miles. Some of the municipal tramways made handsome profits, which materially reduce local taxes. During the current year, it is estimated, Nottingham will clear $90,000 from this source, Liverpool $123,000, Leeds, $300,000, and Manchester $250,000.

Developments in Petroleum During 1902.

A press bulletin of the United States Geological Survey has been issued, giving some details of the developments in petroleum during the year 1902. The most active centres of developments in the oil industry are West Virginia, Kentucky, Kansas, Indian Territory, Louisiana, Texas and California.

The increase in price during that year stimulated work in West Virginia, but the great majority of the new wells were unproductive, and the new production did not offset the failing output of a great mass of old wells. The most conspicuous developments were in Wetzel and Ritchie counties. The indications seem to point to the fact that the richer pools have been defined in this state, but there is an element of uncertainity in the development of all the petroleum fields which makes it inadvisable to make any positive assertion regarding the future possibilities. The production in West Virginia for the year was 213,513,345 barrels, a decline of 4.7 per cent from the previous year.

The development in the southeastern Kentucky field was notable. Much work of developing has been done, and during that year the pipe line from Parkersburg, W. Va., to Somerset, Ky., with a number of branches, was practically completed. The total production of oil in Tennessee and Kentucky was 185,331 barrels, a gain of thirty-four per cent.

In Kansas a new and productive territory was developed, although none of the wells was of the gusher class. The wells are comparatively shallow, ranging from 750 to 850 feet deep, and drilling is inexpensive. The production for 1902 was 331,749 barrels, a gain of eighty-five per cent over the previous year.

In Indian Territory the only pool operated was that belonging to the Osage nation. The total output was 37,000 barrels, coming from thirteen wells, six of which were drilled in 1902.

In Louisiana, wells were sunk over a considerable area in the southwestern portion of the state. The most successful development was near Jennings, ninety miles east of Beaumont, Tex. Small quantities of oil and natural gas are found at other points. The output of the state was 548,617 barrels.

In Texas, $10,000,000 had been spent in developing oil from the discovery up to the end of 1902, and during this time over 24,000,000 barrels of oil had been brought to the surface. The production in 1902, including that stored in tanks, was 18,515,017 barrels. Of this, 7,300,000 barrels were tanked, the rest being consumed locally or shipped from the state. This amount of production places Texas second in the list, being exceeded only by Ohio.

In California the increase in the production of petroleum was remarkable, though fewer wells were drilled than in the preceding year, and operations were partially suspended at one time for lack of means to transport the product that had accumulated. However, the production during the year amounted to 13,974,447 barrels, a gain of about sixty per cent over the previous year. The production of oil has had an effect on the importation of bituminous coal into California, and, at the same time, some of this oil is sent to the Hawaiian Islands, Japan, China and the Philippines.

Street Railway Statistics.

The Boston News Bureau publishes the following interesting abstract of a pamphlet on "Street Railways," issued by Messrs. Graham & Company, bankers, of Philadelphia.

The table of earnings and expenses for 799 companies for the fiscal year 1902 is as follows:

Gross earnings	$247,553,999
Wages and structures	12,118,296
Equipment	16,676,532
Operation of power plants	23,062,828
Operation of cars, transportation and superintendence	62,454,679
Salaries, advertising, stationery, legal damages, insurance	28,000,762
Total expenses	142,312,597
Net earnings from operation.	105,241,402
Other income	2,950,628
Total income	108,192,030
Taxes	$3,078,899
Interest	38,065,911
Rentals, etc.	26,430,243
Total charges	77,595,053
Total surplus applicable to dividends	30,596,977

The combined balance sheet of 967 companies for 1902 shows as follows:

Dr.	
Cost of construction and equipment	$2,167,634,077
Other permanent investments	152,513,997
Cash on hand	28,021,853
Bills and accounts receivable	22,448,700
Supplies	10,610,928
Sundries	19,218,395
Total	2,400,447,950
Cr.	
Capital stock	$1,266,883,289
Funded debt	974,112,422
Bills and accounts payable	101,704,634
Interest and dividends accrued	17,041,493
Profit and loss (surplus)	40,706,112
Total	2,400,447,950

The pamphlet contains the following additional information:

Total companies in United States	967
Length of single track, owned	22,576.99 miles
Length of single track, operated	23,134.44 miles

Track mileage increased 177.9 per cent in the twelve years from 1890-1902.

Payments on capital account:	
Dividends on common stock	$28,737,887
Dividends on preferred stock	4,301,284
Interest on funded and floating debt	38,085,911
Total	71,125,082

Total capitalization per mile amounts to $96,287, of which capital stock constitutes 53.3 per cent and funded debt 46.7 per cent.

Of the amount paid in dividends, $28,737,887 was paid on common stock, the par of which was $562,700,281. This represents an average rate of 5.1 per cent.

The total amount of interest paid was $43,578,961, equal 4.4 per cent on the total amount of $992,709,139 funded debt outstanding.

General statistics of all lines for 1902 shows as follows:

Total number of passengers carried	5,871,957,830
Total number of fares collected	4,809,554,438
Total number of transfers	1,062,403,392
Total passenger car mileage	1,085,397,802
Average fare of passenger per car-mile	4.43

The Faraday Society.

A meeting of the Faraday Society, the British Electrochemical Association, was held on Monday, March 21, at the Institution of Electrical Engineers, Dr. O. J. Steinhart in the chair.

A paper by Dr. F. M. Perkin and Mr. W. C. Prebble on "The Electrolytic Analysis of Gold" was read in abstract by Dr. Perkin.

The object of the researches described was to arrive at an electrolytic method of estimating gold which should be perfectly accurate and yet far more rapid than the ordinary double cyanide method which the authors, differing from Classen, consider inordinately long, even in hot solutions. Solutions of sodium thiosulphate, cyanide, sodium sulphide, potassium thiocyanate and ammonium thiocyanate were all tried and the results compared. The first named was useless; of the others—which are all accurate—the thiocyanates gave the best results and the ammonium salt was better than the potassium. With currents of 0.2 ampere per square decimetre the deposition of 0.05 to 0.08 gramme of gold was complete in five or six hours. With a current of 0.4 to 0.5 ampere one and one-half hours sufficed. The presence of a little persulphate considerably reduced the voltage required. Experiments were also made to determine the best method of removing the deposited gold. Chlorine or bromine water were satisfactory, but slow; aqua regia was risky; the authors recommended a two per cent solution of potassium cyanide containing a little hydrogen peroxide or a persulphate. One or two minutes then sufficed to remove the gold.

An improved form of basin electrode for working with hot solutions was described. A lamp wick syphon, from a small reservoir, supplies water to compensate for evaporation.

Mr. Charles R. Darling read a paper on "Thin-Film Electrolysis, and a Pro-

posed Application to Printing," which was illustrated by experiments.

While investigating a process for letter-press printing by electrolysis without the use of ink—an extension of Bain's well-known telegraph printing—the author found that the final results of electrolysis, when the electrolyte forms only a thin film, often differ materially from those observed in an ordinary cell. In these experiments a carbon or metal plate (it was immaterial which) formed the anode, on this was placed an impression pad, consisting of some sheets of moist blotting-paper, upon this was the trial sheet carrying the electrolyte film, and on this the cathode type or coin.

Voltages from 6 to 200 were employed. To obtain a clear image of the type a certain minimum strength of solution is requisite. The first experiments were made with saline solutions; silver nitrate gave a clear, permanent black image of the type, but the paper of course darkens on exposure; copper sulphate and nitrate yielded images that faded after a time; the same unexpected result occurred with lead, mercury salts and bismuth. The best images were obtained with manganese salts. These consisting as they did of the oxides or hydrates were quite permanent; all purely metallic deposits, excepting silver, disappeared after a time. In the case of non-saline solutions the paper, which might consist of asbestos or pure Swedish filter paper soaked in distilled water, acquired the properties of an exposed photographic plate and on treating with a silver salt and developer a perfect image of the cathode was obtained, even after a long interval. Reproductions of such "electrographs" are given in the paper. The latent images are not due to hydrogen peroxide, nor to metallic compounds, as they occur with carbon electrodes; but they reside in the surface of the paper in contact with or toward the cathode. The author ascribes them to a class of phenomena that has been investigated by Bose and termed "the response of inert matter to electrical stimuli," and thinks they are probably the result of some state of strain set up in the film by the current.

As regards the fading of the metallic images, this may be simply due to recombination, although that explanation is not entirely satisfactory.

During the discussions, in which a number of members took part, Mr. N. J. Bluman said that in some electrolytic printing that he had carried out he had used some organic solutions with good results.

Mr. Fontana suggested that the latent images might be due to occluded hydrogen, a supposition which Dr. Perkin thought could be tested by exposing the paper to an oxidizing agent.

Dr. Steinhart did not agree with the "strain" theory put forward by the author. All materials contain some trace of saline matter, and one is almost sure to get chlorine or some such substance given off on electrolysis.

Mr. Darling replying to Mr. Bluman's remarks, said that organic substances eventually discolored the paper. He did not think hydrogen the cause of the latent images; certainly hydrogen peroxide does not destroy the image.

Production of Mica in 1902.

According to a press bulletin issued by the United States Geological Survey, the use of mica for stoves declined greatly in 1902. On the other hand, there was an increased demand for smaller pieces of mica that were formerly thrown away. Variations in use, production and importation of this mineral are set forth in a report on the production of mica in 1902, by Dr. Joseph A. Holmes, in the annual volume of "Mineral Resources," published by the United States Geological Survey.

The total quantity of mica produced in the United States during the year 1902 is reported to the survey as follows: plate mica, 373,266 pounds, valued at $83,843; scrap mica, 1,028 short tons, valued at $13,081; mica, rough as mined or unmanufactured, 372 short tons, valued at $21,925. This makes a total value of $118,849. The increase in the production of plate mica during the last three years is due to the increasing quantity of small-sized discs and rectangular sheets that have been cut for electrical purposes. In recent years scrap mica has also been manufactured into covering for boiler tubes and steam pipes, to take the place of the more expensive asbestos. Waste mica, not available for other purposes, is used in the manufacture of wall papers and lubricants. During the year 1902 there was a falling off in the production of mica. The amount produced was only 1,150 short tons, valued at $14,606, as against 2,171 short tons, valued at $19,719, in 1901.

There was a marked increase in the importation of mica during 1902, the increase being valued at $131,278, which is larger than the total value of the mica produced in the United States during that year. This illustrates the increasing demand for mica in this country. The greater part of this mica comes from India, although Canada is also a large contributor. Many of the mines in this country are owned by small producers, and when the mica in these begins to give out, or is poor, they have no means to carry on much dead work, and have no other deposit to help fill out the deficiency.

Although mica is well distributed in the United States, actual mining has been limited during the last few years to North Carolina, New Hampshire, South Dakota, New Mexico, Idaho, Virginia and Colorado. Some development work has also been carried on in California, Nevada, Maine, Alabama and Georgia. In several of these states good deposits of mica are known to exist, that are not available on account of the difficulties of transportation.

A Steam Turbine with Isothermal Expansion.

A British patent recently issued to Mr. S. Z. de Ferranti, which covers a type of steam turbine which the author believes will effect considerable economy in operation, is abstracted in a recent issue of the *Mechanical Engineer,* London. It is the endeavor of the inventor to expand the steam in this apparatus isothermally. The economy claimed for the method is said to be due to the fact that the nearer the expansion of the fluid approaches the true isothermal expansion, the greater is the quantity of heat which it is possible to convert into work per unit weight of working fluid.

The invention consists, broadly, in reheating the steam in a multiple-expansion turbine between the various stages of expansion, so that the total expansion is approximately isothermal, and the temperature of the exhaust may be nearly that of the fluid supplied to the engine. In the method described, a turbine of the multiple stage, of the de Laval or any other known type, may be employed, but each stage is separated in such a way that the steam exhausting from the first is passed through a reheater, delivering it into the outlet of the second, and from the exhaust of the second it passes to a second reheater, and so on. The turbine is arranged on a horizontal shaft, with the reheaters below the turbine body, the reheaters being two elements situated in a combustion flue which also contains the boiler, superheater and water-heating elements. In the exhaust passage of the turbine a regenerator coil is arranged so as to extract the heat from the exhaust. The passages to the surfaces of the reheating elements are arranged so as to be capable of handling the increased volume of steam as it passes through.

Reviews of Current Engineering and Scientific Literature.

An Electric Tachymeter.

A simple electric tachymeter has been devised by MM. Chauvin and Arnoux, which is suitable for indicating the speed of any mechanism. The apparatus consists of a small magneto-generator of peculiar construction, and an indicator voltmeter. The magneto may take several forms, but consists essentially of a fixed coil of wire, through which passes an iron core provided at its opposite extremities with poles projecting in opposite directions. This arrangement is placed between the poles of the permanent magnet, and leads are carried from the coil to the voltmeter. If the core be rotated by any means, an alternating electromotive force is set up in the coil which is proportional to the speed of rotation. The revolving part is driven by means of a small round belt.—*Translated and abstracted from Electro (Brussels), February.*

An Electric Regulator.

Speed governors or prime movers, whether of the steam or hydraulic type, which for their action depend upon a change in speed of the engine after any change in load, bring the speed back to normal through a series of oscillations. This is particularly true in governing turbines, since the power required to operate the regulating apparatus must be considerable. This condition has been studied by M. Gin, with a view to eliminating these oscillations, and he has found that if the action of the governor be stopped just after it has reached a maximum or minimum speed, the engine will come to its steady speed in the shortest time. He has devised a governor acting upon this principle, and here describes it in detail, giving an analytical discussion of its operation. In this system the work of shifting the regulator is performed by an electric motor, and the motion of the latter is controlled by a centrifugal governor. To the stem of this governor are attached two sets of contacts, and one of these closes the motor circuits as the governor rises, and the other as it descends, thus starting the motor turning in one way or the other, and it continues to operate as long as the circuits are closed. The circuits are closed at the first movement of the governor, and as it continues to move the set of contacts attached to the governor carries with it the corresponding set against which it is pressed. When the governor reaches its point of maximum travel, and begins to return, the circuits are opened and the regulating motor is thrown out of service, and the governor then returns to its normal position, without again closing the circuits. The apparatus has been worked out ingeniously, the circuit being closed by means of cylinders containing mercury.—*Translated and abstracted from L'Éclairage Electrique (Paris), March 12.*

Earth Connections.

The subject of earth connection is very appropriately discussed by Mr. W. Moon. He gives data on the conductivity of various kinds of soil, and describes the proper method of making measurements, and of securing suitable ground connections. While it is generally supposed that a damp situation and porous soil are the only necessary conditions to obtain a good earth connection, this is not the case, since much depends upon the nature of the soil. Sands and gravels conduct principally by moisture or damp clay in the interstices, but clays appear to have a true conductivity, some of them giving a lower resistance than that of the water with which they are moistened. The conductivity of certain rocks also seems to depend upon the nature of the rocks themselves. Pure clay has the lowest resistance of any natural soil. A sample of London blue clay gave a resistance of 870 ohms per cubic centimetre. The presence of sand decreases the resistance. The high conductivity of clays and sands seems to be due to the smallness of the particles of which they are composed. Long-continued action of the current lowers the resistance of soils; rest raises it. Tables are given showing the resistance of various kinds of soil, and also giving the effect of a continued passage of current. It is interesting to note that Portland cement, which is usually supposed to be a fair insulator, has a low resistance compared with many of the natural stones. Under the best condition it compares with hard brick. In measuring resistance of rocks, it is necessary to wipe the surfaces quite dry, when connection may be made by spreading a thin layer of clay on opposite sides, and then pressing tin-foil on the clay. When the effect of moisture is to be determined, it is necessary that the harder rocks should be soaked for a long time. In making these measurements, care should be taken to correct for any polarization effect caused by the passage of the current.—*Abstracted from the Electrical Review (London), March 18.*

Polarization in Roentgen Rays.

Some experiments have been made by Mr. Charles G. Barkla, in order to determine whether any polarization takes place, due to Rœntgen rays. As explained by Dr. J. J. Thomson, Rœntgen rays consist of a succession of electromagnetic pulses in the ether. Therefore, each ion in the medium has its motion accelerated by the intense electric fields in these pulses, and consequently is the origin of a secondary radiation which is most intense in the direction perpendicular to that of the acceleration of the ion. If, then, a secondary beam be studied, the direction of propagation of which is perpendicular to that of the primary, it will, according to this theory, be plane polarized, the direction of electric intensity being parallel to the pulse front of the primary beam. It occurred to the author that as Rœntgen radiation is produced in a bulb by a directed stream of electrons, there is probably at the anti-cathode a greater acceleration along the line of propagation of the cathode rays than in a direction at right angles. Consequently, if a beam of X-rays, proceeding in a direction perpendicular to that of the cathode stream, be studied, it should show a greater electric intensity parallel to the beam than in a direction at right angles. He used a beam of this sort as the primary radiation, and studied, by means of an electroscope, the intensity of secondary radiation proceeding from a sheet of paper in a direction perpendicular to that of propagation of a primary beam. By turning the bulb around the axis of the primary beam studied, the intensity of this beam was not altered, but the intensity of the secondary beam was found to reach a maximum when the direction of the cathode stream was perpendicular to that of propagation of the secondary beam, and a minimum when these two were in parallel. Several methods were tried, all of them giving similar results. The variation of intensity of the secondary beam amounted to about fifteen per cent of its value, but this does not represent the true difference, as beams of considerable cross-section were studied. Consequently, secondary rays making a considerable angle

with the normal to the direction of propagation of the primary rays were admitted into the electroscope.—*Abstracted from Nature (London), March* 12.

Do the Rails of Electric Tramways Conduct?

The question is raised by M. Emile Guarini, whether the rails of an electric railroad, when used for the return circuit, act as conductors, or merely as grounding plates. He attempted to settle this question by means of a delicate relay which he thought could be operated by a magnetic field set up when current was passing through the rails. This instrument, however, did not respond, and was discarded for a delicately balanced compass needle. The latter, when placed near a city tramway, behaved very peculiarly. When a car approached the point where the instrument was placed, it deviated from the horizontal, the deviation increasing until the car was nearly opposite. It then decreased to zero, and as the car passed it again deflected to the maximum, and then gradually returned to zero as the car passed on. The author believes these experiments can not be explained by the assumption that the return current of railways passes through the rail, for, were this the case, the effect of these currents upon the compass needle should be the same, no matter where the car happened to be, provided the compass were between the car and the station. On the other hand, were the car between the compass and the station, the current taken by the car should not affect the needle. M. Guarini therefore comes to the conclusion that the rail acts simply as grounding plates and that the current returns to the station through the earth.—*Translated and abstracted from La Revue de l'Électricité (Lausanne), March* 15.

Electric Haulage in Mines.

At a recent meeting of the National Association of Colliery Managers of Great Britain, a paper was read by Mr. George Farmer, discussing the relative advantages of electric haulage. The unfortunate diversity of opinion in this matter was held to be due to the fact that different electric companies advocate different systems, each praising his own and decrying the others. This diversity of opinion hangs upon the question, is electricity safe? In colliery work it is not always economy that can be considered. Conditions relating to safety of life render a high standard and a high coefficient imperative. As to the question of fire in mines, the behavior of electrical apparatus in enclosed rooms filled with inflammable gas has proved, in most cases, that it may be used without danger of fire. As an explanation of the slow progress made in electrical haulage, it is said that, in a great many cases, the work can be done by means of a rope with steam power applied directly to its propulsion, and, under these conditions, little will be gained by adopting electricity. In some instances the probable life of the colliery makes the change impracticable. On the other hand, if power must be transmitted some distance, compressed air and steam are under a disadvantage. It is frequently said that the electric cable is not permanent and safe in mines, but the same objection may be raised, with equal reason, against steam and air pipes. There should be no more difficulty or danger in transmitting electric power in the mine than in transmitting steam or compressed air. Suitable methods of installing cables are described, though some of them seem rather crude. A method of determining the size of motor required to drive the winding machine is given. In regard to the different systems, the author, himself, considers the three-phase system to be the only practical one, though he does not attempt to give his reasons. Stress is laid upon the care and attention which should be paid to all electrical machinery, since this apparatus is usually more or less delicate, as compared with other apparatus.—*Abstracted from the Mechanical Engineer (London), March* 19.

More Properties of N-Rays.

It has been found by M. R. Blondlot that there are several kinds of N-rays. Those first discovered increased the luminosity of a feebly luminous surface. He has now found a type which has the opposite effect. The new rays he has designated as N′-rays. He has measured the index of refraction and the wave-length of part of the spectrum of these rays. M. Blondlot has also found that a probable explanation of the failure of other physicists to repeat his observations lies in the fact that the emission of light is effected by the N-rays, in the sense of being concentrated upon a normal, rather than upon a tangent plane. Thus, if an observer is watching the surface perpendicularly, it brightens up, while if he looks along it, it appears to become duller. This condition is just reversed by the N-rays. The effect of the magnetic field, as observed by Gutton, appears to be the same.

As the wave-length of N-rays is extremely small, it might be expected that the rotation of polarized light produced by a magnetic field would be very pronounced. This has been investigated by M. H. Bagard, who used a prism of aluminum to separate the various beams of N-rays and polarized them by means of a glass plate held at a suitable angle. The source of the rays was a Nernst lamp. The polarized rays were transmitted either through aluminum or through carbon bisulphide placed in a magnetic field. Even with a weak field, the rotation observed is very large, amounting to a maximum of forty-five degrees in the case of aluminum, and fifty-four degrees in the case of carbon bisulphide. Repeating the same experiments with ordinary light, rotations of only four minutes were obtained.

Electrical Methods of Measuring Temperatures.

The third lecture on "Electrical Methods of Measuring Temperatures," was delivered by Mr. H. L. Calendar before the Royal Institution (England) on March 10, and during this the applicability of the electrical method was shown. For this purpose a small motor-cycle had been set up in the lecture room, and five thermo-couples had been screwed from the outside into the cylinder wall of a small engine. As the thickness of the cylinder casings is about one-eighth of an inch, it is assumed that the temperature indications of the thermo-couples could be taken to represent the internal temperatures. One couple was placed near the exhaust, one in the inlet, and the other three were fixed near the top, middle and bottom of the stroke; respectively. The temperatures at the various points were determined. It was shown experimentally that the temperature at the exhaust side of the cylinder was considerably higher than at the inlet side, but by directing a blast of air from a small fan against the exhaust, this order of things might be reversed, and the engine, in consequence, rendered more powerful. The measurements indicated that the temperatures at the different points differ but little. During this demonstration the Hospitalier indicator was used, which by means of a beam of light threw the indicator diagram upon a screen. The diagrams were perfectly continuous, and, with their aid, the influence of a retarded or advanced spark, under various compositions of the gaseous mixture, could be studied easily.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

New Railway Telephones.

The Mayer & Englund Company, of Philadelphia, Pa., has designed a new line of telephone apparatus especially adapted to meet conditions existing on street railway lines and interurban roads. The accompanying illustrations show two of the principal types of these telephones. Fig. 1 shows an iron box telephone which is designed for attachment to either iron or wooden poles. The outer case is made of malleable iron and the door equipped with a Yale lock. The whole apparatus is made weatherproof.

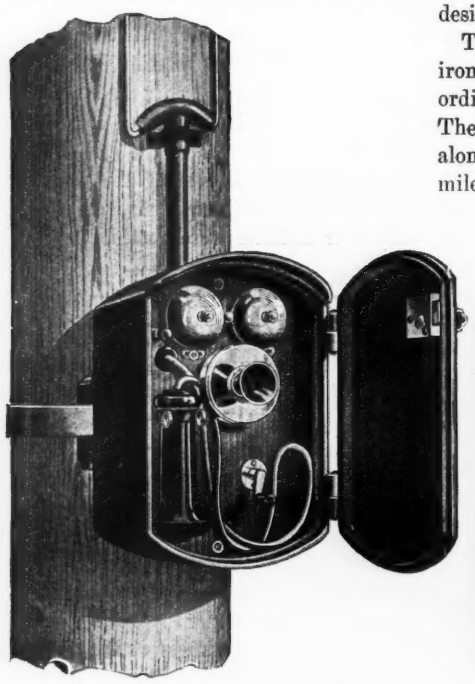


FIG. 1.—RAILWAY POLE TELEPHONE.

All of the working parts of this telephone, including batteries for the local circuits, are attached to one backboard which is held in place in the iron box by two screws. This, of course, facilitates the work of inspection and repairs, as by the removal of the two screws the entire mechanism can be taken out, leaving the empty iron case on the pole. The inside parts of the telephone are interchangeable, and the entire system can easily be kept in good condition by having one or more extra sets of parts on hand mounted on the board.

Fig. 2 shows a portable car telephone. The interior equipment and the arrangement of this telephone, all of which are mounted on one board, as well as the operating parts themselves, are identical with those of the pole telephone, the only difference being that this outfit is installed in an oak box, with a leather carrying strap. Ten to twenty feet of cord are supplied wih this instrument, and at the end of the cord there is attached a plug which is made to be inserted in a specially designed jack box shown in Fig. 3.

These jack boxes are made of malleable iron and are weatherproof, and under all ordinary conditions are also tamper-proof. The jack box may be installed on poles along the line of the road, one to each half mile or so, and communication had with the central office by plugging in at these points. The length of the cord will allow the motorman to leave the instrument in the vestibule of the car so that it need not be exposed in stormy weather, the vestibule forming a telephone booth.

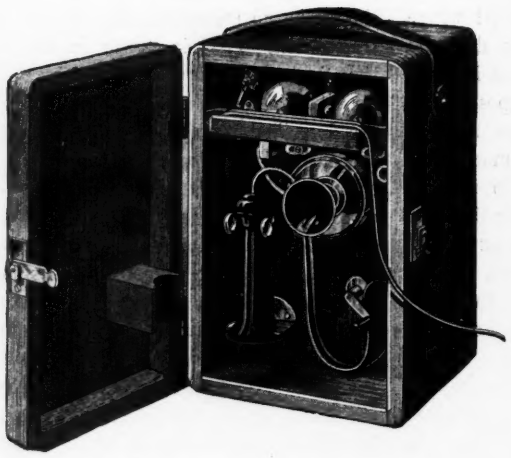


FIG. 2.—PORTABLE RAILWAY TELEPHONE.

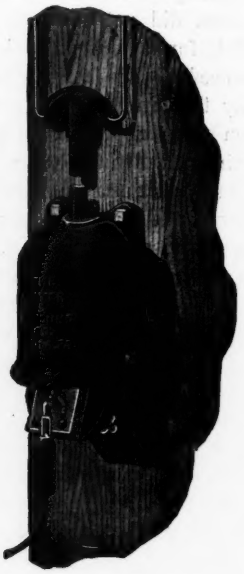


FIG. 3.—JACK BOX.

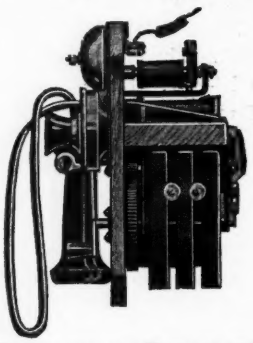


FIG. 4.—BACKBOARD AND DETAILS OF MECHANISM, RAILWAY TELEPHONE.

Fig. 4 shows the details of the mechanism, which is mounted on the board. The instruments are made with standard long-distance transmitter, bipolar receivers and full-sized hooks with ample contact surfaces. While the instruments are very compact, they do not contain any miniature parts, everything being of the full standard size and therefore conveniently and quickly renewed. The generators are generally wound for 40,000 ohms, and the ringers for 1,600 ohms.

A Summer School for Artisans.

The fourth annual session of the Summer School for Artisans, held under the direction of the college of engineering of the University of Wisconsin, will begin June 27 and continue for a period of six weeks.

Courses of study are offered in the following subjects: steam, gas and other heat engines; applied electricity; mechanical drawing and machine design; materials of construction, fuels and lubricants; shop work.

The instructional force is taken from the regular faculty of the college of engineering, and the entire laboratory and shop equipment belonging to the college are used by the students of the summer school.

The requirements for admission do not extend beyond a working knowledge of English and arithmetic, but the policy is to allow a large amount of individual work, so that the student may take advantage of all the preparation he has obtained. The school offers to those unable to take a regular four-year course an opportunity of obtaining a practical working knowledge of the methods of testing

and the use of instruments, together with such theoretical principles in each case as the nature of the subject and the preparation of the student may permit. Bulletins describing the work of the school in detail will be sent on application to Frederick E. Turneaure, dean of the college of engineering, Madison, Wis.

A High-Tension Strain Insulator.

The Locke Insulator Manufacturing Company, Victor, N. Y., was called upon a short time ago to develop insulation for use under rather unique conditions. The problem was to furnish insulation for 120,000 to 140,000 volts and to provide a tensile strength of 5,000 or 6,000, and the illustration herewith will give an idea

HIGH-TENSION STRAIN INSULATOR.

of the method of solution. The porcelain insulators are surrounded at the top by forgings which, in turn, are inserted into the pin-hole of the next insulator. By this method of placing the insulators in series, ample insulation is provided. This insulator, which is known as No. 610, will, no doubt, be of service to many for lower voltages where excessive strain occurs in transmission work.

An Electrically Equipped Parlor Car.

The Barney & Smith Car Company, of Dayton, Ohio, has recently supplied a handsome parlor car to the Erie Railroad for its Tuxedo service. The accompanying illustration shows a view of the interior of this car. Not only is there a complete installation of lamps, but the circuits are so arranged that the illumination can be graduated over a considerable range, and the car is also supplied with electric fans and a ladies' hair-curling apparatus.

No. 12 wire is used throughout the car and the pressure is fifteen volts. Dynamo and battery wiring to the switchboard is of No. 1 cable run through heavy canvas hose, strapped to the bottom of the car. From the switchboard a double-circuit, two-wire system is used, by means of which each side from the centre line of the car is supplied with a complete system. There are fifteen circuits in all. These are arranged in the following order: eight to the centre fixtures, four on the two deck sills, two for the three fans and one for the curling-iron heater which is located at a ladies' dresser. A common return or negative main carries one side of each circuit to the switchboard. The positive sides of the lighting circuits are connected single-pole in pairs through double-pole Bryant switches and double-pole plug cutouts, keeping the circuits separated and at the same time enabling the two sides of the car to be operated simultaneously.

Independent circuits supply current to the fan and heater. A Hart flush electrolier switch is so connected with the fan resistance as to enable three speeds to be obtained. The system of wiring makes it possible to get into the main part of the car on the four auxiliary or day circuits any number of lights from one to ten, and by bringing into service the other eight circuits almost any number of lights from one to forty-six may be put in service. Sixty-eight eight-candle-power, twenty-five-volt, clear spherical globe lamps are installed. These with three twelve-inch Diehl fans and one curling-iron heater make up the electrical equipment. The generating and storage battery equipment is of the Gould type.

INTERIOR VIEW OF ELECTRICALLY EQUIPPED PARLOR CAR.

Small Single-Phase Motors.

The General Electric Company, Schenectady, N. Y., has introduced a new series of small single-phase motors of the "induction" type, without commutator or any electrical connection to the rotating parts.

SMALL SINGLE-PHASE MOTOR, WITH RESISTANCE IN SUBBASE.

DESIGN OF SINGLE-PHASE MOTORS, BELOW ONE HORSE-POWER IN CAPACITY.

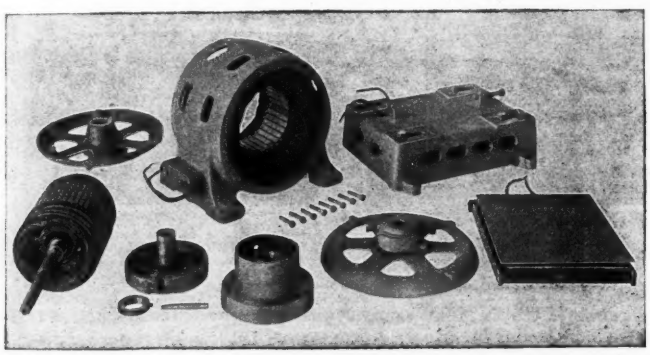
The motors, the maker states, possess a high power-factor and efficiency; high starting torque, with low starting current; simple design and strong construction; and require but little attention during operation.

The field, or primary windings, is embedded in well insulated slots in the laminated field. Interwoven with the main windings is an independent winding connected to a condenser in the subbase of the motor. This condenser winding, which becomes excited by transformer action, is so located with respect to the several poles of the field as to produce a cross-magnetization or revolving field. The motor, therefore, has the necessary self-starting characteristic. While running, the reaction between currents in the armature and the condenser winding in the field slots is such that the condenser winding supplies the magnetizing currents of the motor. The current taken from the line is therefore of high power-factor.

The slotted armature has its star-connected three-phase windings carried to the terminals of a resistance within the armature head. In one end of the armature is located a centrifugal switch which, while leaving the resistance in series with the armature circuit at the time of starting, automatically short-circuits it after the motor has reached about two-thirds full speed.

While with this arrangement the resistance is of necessity cut out at a single step, the operation is so perfect that, as shown by oscillograph records, the current while starting only exceeds full load value for a fraction over one second.

The motor is also provided with an automatic friction clutch pulley which permits the armature and shaft to revolve freely, the pulley with its belt standing still until the motor has reached about three-fourths speed, when the centrifugal weight expands a strap within the hollow rim of the pulley, enabling the motor to easily pick up its load. As the starting of these motors is entirely automatic, necessitating simply the closing of the line switch, the motors will start again without any personal attention should the current supply become interrupted and afterward restored.



AN EXPLODED SMALL SINGLE-PHASE MOTOR, SHOWING ASSEMBLY.

The construction of the motor embodies every improvement suggested by years of experience on the part of the company's engineers. Special attention has been given to the design of the shaft and bearings, the latter being of liberal length to minimize wear. The bearings are self-oiling, with liberal reservoir capacity.

The subbase containing the condenser serves also as a base for the motor, which slides upon it in parallel grooves with belt tightener adjustment. The condensers are hermetically sealed in sheet metal cases, thus avoiding danger of trouble due to moisture.

For motors below one-horse-power capacity, a modification of the above design is adopted. The field winding is of the split-phase type, one phase being directly across the circuit, while during the period of starting the second phase is connected across the circuit in series with a fireproof resistance contained in the base of the motor. This gives the necessary displacements of currents in the two windings to produce the starting torque. The starting circuit is controlled by a magnetic switch, located within the frame of the motor, and which operates by increase in field current during the period of starting. As the motor approaches its full speed the field current reduces to its normal running value, and the switch automatically opens the starting circuit. These small motors have permanently short-circuited squirrel-cage armatures. The switch contacts (of carbon and copper) are enclosed in a practically air-tight space, so that all danger from arcing is eliminated.

Incandescent Lamp Manufacturers and the Patent Situation.

As a result of a number of meetings held at the Manhattan Hotel, New York, during several days of last week, it is announced that nearly all of the companies manufacturing incandescent lamps in the United States became licensees under the several patents relating to incandescent lamps and certain processes for their manufacture, controlled by the Edison Electric Light Company, a company affiliated with the General Electric Company. These patents have approximately ten years to run and it is announced that the licenses to these several companies are issued for five years with the privilege of a further renewal of five years.

Mr. J. H. Wormley, the secretary of

these meetings, announces that the following companies are thus licensees under this general movement:

Downward Light Electric Company, New York.

The Sterling Electrical Manufacturing Company, Warren, Ohio.

The Brilliant Electric Company, Cleveland, Ohio.

The Banner Electric Company, Warren, Ohio.

The Franklin Electric Manufacturing Company, Hartford, Ct.

The United States Incandescent Lamp Company, St. Louis, Mo.

The Standard Electrical Manufacturing Company, Niles, Ohio.

Capital Electric Company, Denver, Col.

Gilmore Electric Company, Boston, Mass.

Liberty Electric Company, Pittsburg, Pa.

Warren Electric and Specialty Company, Warren, Ohio.

The Colonial Electric Company, Warren, Ohio.

Shelby Electric Company, Shelby, Ohio.

Bryan-Marsh Company, Marlboro, Mass.

The Buckeye Electric Company, Cleveland, Ohio.

Munder Electric Company, Springfield, Mass.

Sunbeam Incandescent Lamp Company, St. Louis, Mo.

Independent Incandescent Lamp Company, Cleveland, Ohio.

New York & Ohio Company, Warren, Ohio.

Fostoria Incandescent Lamp Company, Fostoria, Ohio.

General Incandescent Lamp Company, Cleveland, Ohio.

National Electric Lamp Company, Cleveland, Ohio.

This leaves seven or eight companies which have not entered the license agreement, but it is said that these companies are likely to do so. In fact it is said that it is a stipulation that all companies which were exclusively manufacturers of incandescent lamps on April 1, 1904, are entitled to the license privileges.

It is announced that about thirty suits have been entered by Dyer & Dyer, attorneys for the General Electric Company, against jobbers, dealers and consumers, in connection with these patents, and it is announced that all these suits will be withdrawn.

It is generally believed that the result of these meetings will eliminate largely the warfare which has been carried on among manufacturers for several years in the matter of prices on incandescent lamps and that a more stable market will obtain hereafter.

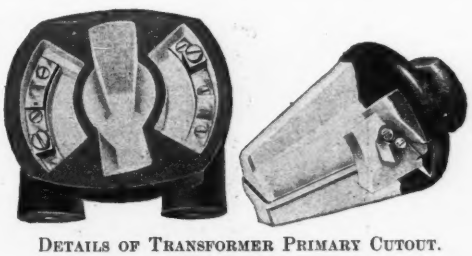
Transformer Primary Cutout.

An improved form of a transformer primary cutout designed to protect the high-tension side of transformers is being introduced by the Westinghouse Electric and Manufacturing Company.

It is made entirely of porcelain, and its form is such that it has high insulating and arc-breaking qualities. The plug to which the fuse is attached projects between the terminals, the upper end of it rising well into the top of the block and interposing an effective barrier, and thus making it impossible to maintain an arc. The fuse is eleven inches in length, making a long break, and is so placed that the vapors of a discharge are blown down and out of the device and away from the terminals.

TRANSFORMER PRIMARY CUTOUT, ASSEMBLED.

The line wire is carried directly to the top of the device and attached to it as to an ordinary insulator, which it thus displaces. To reach the terminal the wire must be bent around the edge of the block and is so supported in an angle between the terminal post and the porcelain case that it can not be loosened by any swaying of the wire in the wind.



DETAILS OF TRANSFORMER PRIMARY CUTOUT.

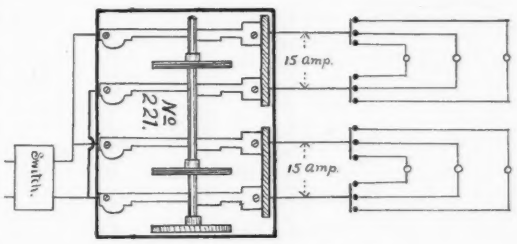
The plug enters from the bottom. When it is raised into place, a partial turn draws the knife blades on the plug into the jaws on the block, preventing the plug from dropping out or being blown out.

All live parts are protected from the weather by the projecting edges of the block and by placing the terminals well above its lower surface, with no apertures in the side or top. A bend in the fuse wire brings it into plain view at all times, and it is thus possible to observe its condition without removing the plug, guarding against any liability of opening the circuit when there is a current upon the line.

It is fastened to the cross-arm or other support by two screws, passing through porcelain tubes which form a portion of the block. It has a rated capacity of 2,500 volts, thirty amperes. It is small, light, easy to install and to re-fuse, and forms a very desirable addition to the assortment of high-grade electrical line apparatus.

A New Type of Sign Flasher.

The Reynolds Manufacturing Company, 177 Adams street, Chicago, Ill., has placed on the market a new departure in the form of a sign flasher for advertising display. This new type of flasher is known as the Dull's carbon. The design of this new machine for flashing electric signs or displays is such that it is possible to flash a heavy current without dividing the load up into small circuits and flashing them in unison. It may be readily understood that this can not be done after the burning of the blades has once been started. Not only will the circuits come on unevenly, but as the machine becomes worn the circuits break off unevenly, making a ragged and unsatisfactory effect. This relates particularly to flashing a sign on and off as a whole or on alternate sides. The carbon machine is set in the mains leading to the sign, and not in the sub-circuits.



DULL'S CARBON SIGN FLASHER.

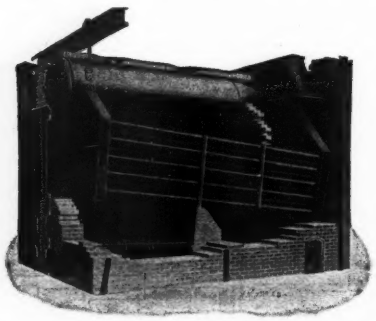
The accompanying illustration shows the location of the carbon, which is fitted to a small sign of fifteen amperes on a side, flashed alternately. The cutouts are as near to the sign as possible, and but four wires are carried down to the flasher. This saves considerable wiring, if the sign

happens to be at some distance from the machine, and the machine is of a construction where sub-circuits are necessarily carried from it to the sign.

These machines break the load on both carbon and metal, the arc being taken by the former both on the make and break. There is no heating, and therefore the carbons do not break out. The manufacturer states that they will last indefinitely on small loads. Where fifteen amperes are controlled, the carbons require dressing or readjusting about once in two years, and for fifty amperes, about once in six months. These machines are made in all sizes and styles from 15 to 200 amperes.

The Keeler Water-Tube Boiler.

The accompanying illustration shows the Keeler water-tube boiler manufactured by the E. Keeler Company, of Williamsport, Pa. This boiler is of the box



THE KEELER WATER-TUBE BOILER.

header type and has a horizontal steam and water drum. The steel outlet is placed in the centre of the drum, where it is removed from the rapid upward rush of water and steam coming from the front header and is provided with a large size dry pipe or separator. The long rear header allows for expansion and contraction of the tubes without bringing undue strain on the seams connecting the drums and headers.

The tubes are straight and inclined one inch to the foot. The headers are eight inches deep inside, all open, allowing uninterrupted circulation. The throat covers one-half of the circumference of the drum, which is reenforced at this point by three bridges of plate and by the throat flanges. All drums above thirty-six inches in diameter have triple-riveted, double butt-strapped straight seams.

The wrapper sheet is flanged inside of the large header plate, this being a process which has been patented by the Keeler company. The boiler is of wrought steel throughout, no cast iron or cast steel being used except for the hand-hole plates. All the hand-hole plates are faced in a special machine, and the joint, with the header, is backed with a special rubber composition or metallic gasket.

The feed pipe entering the front drum head is carried back into a mud drum of large size. The temperature of the water and steam in the drum at this point is sufficient to cause a deposit of nearly all of the scale-producing matter, the purified water going out at the top and front end of the mud drum, while the impurities are deposited in the mud drum where they settle and are blown off at the back. A blowoff pipe is connected to the back end of the mud drum and extended through the entire head end of the steam and water drums, and at this point it can be connected to the main blowoff pipe or left with a separate outlet so that the character of the impurities in the feed water may be determined.

The front end of the boiler is swung from two heavy channels which rest on wall plates. The rear header rests on expansion plates, giving a flexible setting unaffected by expansion or contraction. The front is sheet steel with heavy cast-iron doors and frames. This is made sectionally so that a mechanical stoker can be installed without a change in construction. The rear header is completely enclosed, doing away with loss by radiation. An angle iron frame and sheet-steel tube door is provided for the rear setting wall. Heavy cast-iron side cleaning doors are provided, and the cleaning openings are so arranged that no cold air is admitted, while if desired the holes in the stay bolts are made large enough for the use of a steam blower in front.

These boilers are built in units from 50 to 675 horse-power, and also in special sizes to suit space and conditions. The standard boilers are built for a working pressure of 150 pounds, but if desired they can be built for any pressure up to 250 pounds. The grate surface is carefully proportioned and air space regulated by the class of fuel to be burned.

The Keeler company has branch offices at Boston, New York, Philadelphia, Pittsburg and Chicago.

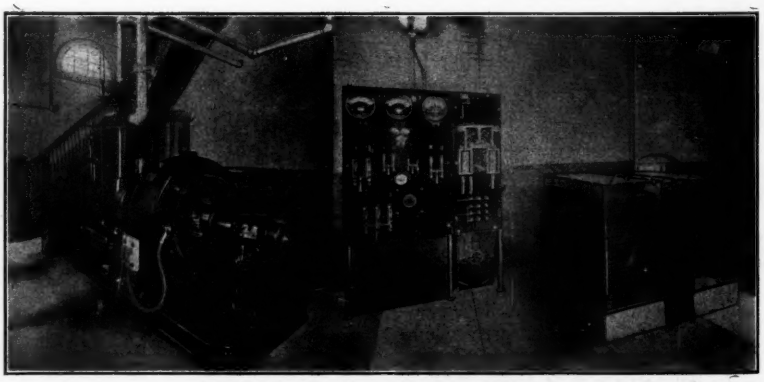
The Thomas S. Clarkson Memorial School of Technology.

The first issue of the *Clarkson Bulletin*, to be published quarterly, contains the address by Dr. Frederick A. C. Perrine, delivered on founder's day, entitled, "The Success of the Educated Man," and a brief account of the foundation of the school, explaining its aims. The equipment of the school and methods of instruction are also described.

Isolated Storage Battery Installation.

The Broome County buildings at Binghamton, N. Y., give an interesting instance of the opportunity for the advantageous installation of an isolated electric lighting plant served by an auxiliary storage battery. This plant, as first installed, included a ten by nine Westinghouse Junior engine, direct-connected to a thirty-seven and one-half kilowatt Westinghouse 110-volt generator. There was some question about the economy of the plant, as during the period when there was not much lighting necessary it was found cheaper to burn gas. It was decided, in order to make the installation more complete, to add a storage battery, and the contract for this was awarded to the Smith Storage Battery Company, of Binghamton, N. Y. This addition consisted of fifty-six elements of 280-ampere-hour capacity, of the tray type, together with a battery panel addition to the switchboard, provided with the necessary switches, volt and ammeters, circuit-breaker and voltage regulator.

The battery is arranged in two piles of twenty-eight trays each, twenty-two by forty-eight inches, entirely enclosed in glass to reduce vibration and exclude dust, the whole presenting a neat, simple and workmanlike appearance. The result of this addition has been that the electric light is used exclusively, and the engine during the winter season is run about five hours per day. It is estimated that an investment of $10,000 is saving the county about $2,000 per year.



ISOLATED PLANT AT BROOME COUNTY BUILDINGS, BINGHAMTON, N. Y.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

BIG MERGER COMPANY DISSOLVES—Announcement has been made of the dissolution of the Norfolk, Portsmouth & Newport News Company's $9,000,000 merger. This was a combination of practically every electric line, ferry, heating and lighting system in southeastern Virginia.

STANDARD POWER COMPANY FILES ARTICLES—Articles of incorporation of the Standard Power Company, organized in Salt Lake City, Utah, with a capitalization of $1,000,000, have been filed in the office of the county clerk. The company will utilize a portion of the waters of the Sevier river in conducting the business for which it is incorporated. The stock is divided into 1,000,000 shares of the par value of $1 each. The officers are Willard F. Snyder, president; Robert Forrester, vice-president; John B. Weimer, secretary and treasurer.

MARCONI COMPANY IN AGREEMENT WITH THE BRITISH GOVERNMENT—At a meeting of the Marconi Wireless Telegraph Company, held in London on March 30, the chairman stated that the year's receipts had exceeded expenditures by £10,607. He also stated that an agreement had been made with the postal authorities. This agreement, it is understood, places the company on the same ground as the cable companies, so far as the receipt and despatch of messages are concerned. Wireless messages by the Marconi system, filed at sea to be retransmitted from Marconi coast stations to destinations in Great Britain, will be treated the same as cable despatches.

TO EXTEND INDEPENDENT TOLL LINES—As the result of a conference of managers of independent telephone associations, held at Indianapolis last week, there will be considerable interchange of long-distance messages. This will be undertaken by the United States Telephone Company, of Cleveland, and various other independent companies of Buffalo, Pittsburg, Philadelphia, Wheeling, Chicago and St. Louis. These connections will make it possible to have service over independent wires from Cleveland to Buffalo and Albany, Philadelphia and other cities named, also giving service to Kansas City and through Colorado and Texas. A forty-mile extension will be constructed from Dayton, Ohio, to Richmond, Ind., which will give the United States company connection through to St. Louis. This connection, it is expected, will be built and in working order before the exposition opens. Another extension, of about the same length, will be built from Dennison to Cadiz, and to the Ohio river. A small gap between Erie and Buffalo will be connected up, and this will give a circuit to Albany and Philadelphia; while another gap from the state line west of Toledo to South Bend, Ind., will be connected up, giving a through wire to Chicago.

A NEW TELEGRAPH COMPANY—News comes from Chicago that there was incorporated at Springfield, Ill., on March 24, a new company known as the United States Telegraph and Telephone Company, which is virtually a consolidation of all the independent telegraph and telephone companies of the United States. The plans of this company are to compete with the Postal and Western Union companies. The incorporators of the new system, it is understood, will make such arrangements that a person can either telegraph or telephone from any booth operated by this company. The capital stock is estimated at $50,000,000 or $100,000,000, and it is supposed that large German interests are involved. The statement is made that, besides twenty-seven independent telephone companies which have already entered the combination, the National Telegraph News Company, of Chicago, the Chicago & Milwaukee Telegraph Company and the Kinloch Company, of St. Louis, will be added. H. B. Critchfield, manager of the Automatic Electric Company, will have supervision over the installation of the improved instruments and connections. G. Watson French, of the Republic Iron and Steel Company; Henry E. Weaver, of the Weaver Coal Company; H. Rubens and H. A. Turner are thought to be interested in this incorporation.

WATER POWER FOR ELECTRICAL DEVELOPMENTS IN CALIFORNIA—The Eureka Lighting Company, of San Francisco, has concluded to begin at once the development of its power water rights on the Trinity river for the purpose of generating electricity for power and light. The rights are sufficient for the production of 6,000 horse-power, which is at present fully double the amount that can be utilized. The plans contemplate an expenditure of nearly half a million dollars, and the result will be a power line passing through Korbel, Blue Lake, Arcata and Eureka, a distance of fifty or sixty miles, and thence on into the Eel river valley. It will do away with the steam generating plants for current in use in Eureka at present, and will furnish an almost unlimited quantity of electricity for all purposes within Eureka. An electric road through Trinity County to the Sacramento valley is one of the possibilities of the plan, as the power plant will be but twenty miles from the present Hay fork road in this county. The enterprise means a great deal for Eureka and Humboldt County, for it is the intention to develop thoroughly the proposition and furnish light and power to every place to which the line can be extended. The cheap power which the company expects to be able to furnish will undoubtedly foster manufacturing in Eureka and open up considerable of the outlying country.

CUBAN ELECTRIC RAILWAY AND LIGHTING PROJECT—The Cienfuegos, Palmira & Cruces Railroad and Electric Power Company has under consideration extensive plans for developing its interests in Cuba. The company is composed of Cuban and German capitalists, and purpose building nearly ninety miles of electric railway, to light eight towns and to construct a hydraulic plant which will have a capacity of upward of 10,000 horse-power. Four and one-half miles of electric tramways will be built in Cienfuegos, one of the most flourishing seaport towns on the island. The population is about 30,000 people. From Cienfuegos the road will be carried on to Caonao, then on to Palmira, from there to Cruces, then on to Ranchuelo and Santa Clara, the capital of the province of that name. Another section will be built from Caonao to Guaos and from there to Cumanayagua. The line will be standard gauge. Owing to the number of sugar and coffee plantations along the route the company intends to cater for a big freight business. The Rio Negro is to be diverted by closing a subterranean passage through which that river discharges its water southward toward Trinidad. By this means its entire discharge will be added to the Hanabanilla river. The power plant will be built at the Hanabanilla falls, which are known as the Niagara of Cuba. The available head, it is estimated, will be about 700 feet. Cornelius C. Vermeule, 203 Broadway, New York, is consulting engineer of the company. Bruno Diaz, of the Bruno Diaz Company, large Cuban tobacco leaf merchants, is president. Contracts are expected to be let inside of three months.

PITTSBURG-WASHINGTON TRACTION SYSTEM—Rights of way are being taken by Senator Flinn, of Pittsburg, Pa., for an express traction line which he will build this summer to Washington, Pa., at a cost of $1,000,000. Nearly all the rights have been secured, but a start will not be made until all have been bought or optioned. The entire route will be through private property, so that no limit to the speed will be imposed. Connection will be made at Library with the Pittsburg & Charleroi line of the Pittsburg Railways Company. From there the distance to Washington will be sixteen miles and will be in an almost direct southwest line. The line from Pittsburg will be thirty miles. One of the most important results of the building of the line will be that Charleroi and the upper Monongahela valley in Washington County will be given a direct entrance to the county seat at Washington, a convenience the people of that section have sought for many years. Washington now has a population of 25,000 and its growth in recent years has been very fast. The line will be single track with sidings and turnouts, but the grading, which will be heavy, will be for a two-track road. One heavy viaduct will be necessary, and it is expected that over 2,000 tons of steel will be necessary for viaducts alone. The new road will make use of the Mt. Washington tunnel, which will be ready for opening September 1. This tunnel will be 3,500 feet long, and has been entirely driven save for a bench of 800 feet at the north end. It will be lined with stone and brick. The new tunnel, which will cost $600,000, will also give a safer and quicker entrance into downtown Pittsburg to the Pittsburg & Charleroi line.

NEW INCORPORATIONS.

ST. PAUL, MINN.—Rallog Telephone Company. $25,000.

BUFFALO, N. Y.—Warner Telephone Company. $50,000.

ST. JOSEPH, MO.—Clarksdale Telephone Company. $2,500.

FRIEND, NEB.—The Saline Telephone Company. $150,000.

RUTLAND, VT.—The Northern Electric Company. $20,000.

HARRISON, OKLA.—The Gotebo Telephone Company. $10,000.

TREADWELL, N. Y.—Treadwell Telephone Company. $3,000.

SPRINGFIELD, ILL.—The Troy Telephone Company. $10,000.

RALEIGH, N. C.—The Mocksville Telephone Company. $10,000.

SHERBURNE, N. Y.—Sherburne Telephone Company. $10,000.

TRENTON, N. J.—People's Rural Telephone Company. $50,000.

IRETON, IOWA—The Reading Township Telephone Company. $1,700.

LANSING, MICH.—Munith & Grass Lake Telephone Company. $2,500.

ALBION, MO.—Edwards County Mutual Telephone Company. $8,000.

PERRYSBURG, OHIO—Maumee Valley Telephone Company. $15,000.

GEORGETOWN, OHIO—Brown County Telephone Company. $20,000.

ST. PAUL, MINN.—Blackduck Electric and Telephone Company. $50,000.

MADISON, WIS.—Citizens' Light, Heat and Power Company. $25,000.

CHICAGO, ILL.—The Hermon & St. Augustine Telephone Company. $1,000.

NEWARK, N. J.—National Gas, Electric Light and Power Company. $10,000.

TERRE HAUTE, IND.—Honey Creek Mutual Telephone Company. $10,000.

PENN YAN, N. Y.—Dundee & Crystal Springs Telephone Company. $5,000.

JERSEY CITY, N. J.—The Indiana & Michigan Electric Company. $2,000,000.

DAYTON, OHIO—Marion, Bucyrus & Tiffin Railway and Light Company. $10,000.

ALLENTOWN, PA.—Allentown & South Allentown Street Railway Company. $10,000.

COLUMBUS, OHIO—The Oberlin Gas and Electric Company. Increased from $75,000 to $100,000.

EUGENE, ORE.—Llewellyn Telephone Company. $400. Incorporators: Eli Perkins, H. A. Bower and Otto Petzgold.

PIKE, N. Y.—Pike Telephone Company. $1,000. Incorporators: G. S. Van Gorden, Henry C. Lathrop, Fred. W. Gild, Pike, N. Y.

WILSON, N. Y.—Wilson Electric Light and Power Company. $2,500. Incorporators: A. F. Bowker, F. H. Tower and Edgar Tower.

POLK CITY, IOWA—Polk County Telephone Company. $3,000. Incorporators: Edward Miller, C. A. Snow, R. H. McLean and others.

CAMDEN, N. J.—Mushagie Electric and Gas Company. $500,000. Incorporators: Joseph F. Cotler, F. R. Hensell and George H. B. Martin.

SPRINGFIELD, ILL.—Fountain Creek Telephone Company. $14,000. Incorporators: W. A. Yeasil, G. H. Weiland and H. C. Tucker.

JERSEY CITY, N. J.—The Monterey Light and Power Company. $500,000. Incorporators: Kenneth K. McLaren, Robert L. Hogust and Roger H. Williams.

CONWAY, ARK.—Conway Telephone Company. $10,000. L. H. Pyle, president; F. E. Perminter, vice-president; G. E. Pyle, secretary and treasurer.

UNIONTOWN, PA.—Masontown Electric Company. $5,000. Directors: Jacob B. Van Waggener, John F. Cockburn, Clarence W. Sheck, Pittsburg.

LITTLE ROCK, ARK.—The Interurban Transit Company. $350,000. President, H. C. Homeyer; vice-president, C. C. Gunnels; secretary, J. G. McDonald; treasurer, C. P. Brice.

ST. JOSEPH, MO.—The Missouri River Telephone Company. $150,000. Directors: Walter S. Dickey, William F. Rankin, Frank S. Travis, John R. Stafford and Ralph O. Stauber.

ALBANY, N. Y.—The Heat, Light and Power Improvement Company of America. $600,000. Directors: James P. Lowery, Andrew Ritchie and Charles T. Eldridge, of New York city.

FARMERSVILLE, TEX.—Farmersville Mill and Light Company. $50,000. Incorporators: H. L. Carver, H. L. Honaker, H. D. Honaker, J. M. Honaker, E. W. Stewart, all of Farmersville.

CHARLESTON, W. VA.—Wheeling & Pittsburg Telephone Company. $100,000. Incorporators: John A. Howard, J. P. Young, W. C. Handlan, of Wheeling, W. Va.; J. G. Splane, R. C. Hall, of Pittsburg, Pa.

STONINGTON, CT.—The Westerly Railway and Lighting Company. $400,000. Incorporators: F. C. Jillson, of Providence; Nathan B. Lewis, of South Kingston, R. I., and Joseph M. Kingelsmith, of Stonington.

LAWTON, IOWA—Lawton Telephone Company. $2,000. Incorporators: J. A. Smith, F. A. Sturtevant, G. V. Walker, Fred. W. Ludwig, R. I. Marshall, J. H. Abernathy, J. W. Carlstrom, J. W. Johnson, C. M. Wray.

EAST STROUDSBURG, PA.—Monroe & Northampton Street Railway Company. $90,000. Directors: C. H. Latta, Bethlehem; William K. Keenman, Bangor; Robert E. Schaeffer, William B. Schaeffer and Philip W. Keenman.

PITTSBURG, PA.—Wilkins & Braddock Electric Street Railway Company. $21,000. Directors: Frank T. Redman and James P. Purcell, of Braddock; John P. Gangwisch, Jr., Crafton, and J. A. Langfitt and Harvey McKinney, of Pittsburg.

BIRMINGHAM, ALA.—Aberdeen Electric Light and Power Company; $15,000; incorporators, E. M. Jones, J. R. Jones, C. C. Tubbs, D. W. Houston and others. Wesson Light and Power Company; $12,000; incorporators, W. H. Harvey, A. E. Graham and others.

JEFFERSON CITY, MO.—St. Francois County Railroad Company. $300,000. Incorporators: Fletcher S. Heath, of New York; Samuel A. Gillett, Alexander Lindmann, Archie Thurlby and R. A. Crandall, of Chicago; Charles W. Markle, of St. Louis, and Albert J. Swart, of Farmington.

MANSFIELD, OHIO—Mansfield & Mount Vernon Traction Company. $10,000. To build an electric line between the two towns. Incorporators: W. W. Branigan, A. B. Beverstock, Mark H. Arnold, E. R. Rumpler, W. A. Hambleton, F. L. Fairchild, C. G. Cooper, A. W. Lindsay, J. D. Dewitt and N. D. Pound.

KIRKMAN, IOWA—Farmers' Mutual Telephone Company. $20,000. Incorporators: R. Anderson, John McDowell, James Bristol, J. H. Schmid, Julius Schmid, Frank Dekoltz, Green Bay Lumber Company, S. B. Olson, D. C. McDowell, W. R. Adams, Neils Anderson, Frank Faltonson, Emanuel Hanson, Ole E. Johnson, H. Dahlof, Christ Christenson, Charles Newhouse, Henry Greve, G. H. Barfield, Andrew Rasch, Henry Rasch, John Morenson, J. T. Peterson, E. C. Fiscus, A. A. Mitten, A. C. Hanson.

CHICAGO, ILL.—Illinois & Kentucky Railroad Company; $2,500; to be constructed from Harrisburg to the Ohio river and to Marion, Carrier, Mills and Eldorado, through Williamson, Saline, Pope and Hardin counties; incorporators and first board of directors, A. M. Conoughey, D. F. Hanrahan, C. M. Miller, J. Hirsch and J. E. Lindquist, all of Chicago. Herrin & Southern Railway Company; $10,000; incorporators and first board of directors, Blewitt Lee, S. F. Andrews, A. P. Humburg, F. L. Delay and E. O. Hunt.

TELEPHONE AND TELEGRAPH.

LEBANON, IND.—It is stated that the Central Union Telephone Company will install a local system.

SPIRIT LAKE, IOWA—The local telephone exchange will be rebuilt by the Western Electric Telephone Company.

LEWISBURG, TENN.—The citizens of Cornersville have organized a company and will operate a telephone exchange at that place.

EAST ORANGE, N. J.—The New York & New Jersey Telephone Company has completed its new exchange to serve Orange and East Orange.

MALVERN, IOWA—The City Telephone Company will build a line out of Emerson and will also install an exchange at Pacific Junction.

BOWLING GREEN, OHIO—Fred. Windisch, of Port Clinton, has purchased the telephone exchange at Prairie Depot and will remodel it at once.

BALLS FERRY, CAL.—The Balls Ferry Telephone Company has been organized to build a line between Balls Ferry, Anderson and Cottonwood.

FREDERICKSBURG, VA.—The Southern Bell Telephone Company has completed its new telephone plant here, and the system has been placed in operation.

KALAMAZOO, MICH.—The citizens of Alamo have organized a mutual telephone company. A. M. Nutten is president and Paul T. Butler is secretary and manager.

CUMBERLAND, WIS.—The Dunn County Telephone Company, recently organized at Ridgeland, Wis., will build telephone lines through Barron and Dunn counties.

RAVENNA, NEB.—J. R. Adamson, of Broken Bow, has been granted a franchise for an independent telephone company. The system is to be in operation by June 1.

DES MOINES, IOWA—The Mutual Telephone Company, at its recent meeting, made arrangements to entirely reconstruct its system, at a cost of not less than $300,000.

LOVELAND, OHIO—It is stated that the Cincinnati Bell Telephone Company will soon extend its lines from Loveland to King's Mills, Maineville, Fosters and other points.

ST. CLOUD, MINN.—The Clearwater Telephone Company has increased its capital stock from $10,000 to $25,000, in order to extend its line to Buffalo, Becker and other points.

TELL CITY, IND.—The Cumberland Telephone Company has absorbed the independent system at Troy, Ind., and has made it a branch of the local exchange of that system.

PORTLAND, ME.—The Northeastern Telephone Company is preparing to extend its lines from Westbrook and Gorham to South Windham, and thence to Raymond and other towns to the north.

OCEAN PARK, CAL.—The city trustees have granted the Home Telephone Company permission to erect poles and wires for long-distance toll stations. The Sunset Telephone Company is preparing to rebuild its lines in this vicinity.

MARLOW, I. T.—The Fort Sill, Oklahoma & Texas Telephone Company, of this place, has been sold to the Texas Telephone Company, with headquarters at Wichita Falls, Tex. The property includes the local exchange and long-distance lines.

GADSDEN, ALA.—It is reported that the Bell Telephone Company contemplates building a line through Wills Valley to connect Gadsden with Chattanooga. Connection with the latter city would place Gadsden in touch with Cincinnati, Chicago, St. Louis, New York and other large cities.

ST. LOUIS, MO.—It is stated that the shareholders of the Bell Telephone Company of Missouri will on May 17 vote to increase the capital stock from $4,000,000 to $10,000,000, in order to provide capital for the removal of overhead wires, the connection of southwest Missouri lines, and other improvements and extensions.

ALBION, N. Y.—Guy L. Merrill, of this place, who has been given a permit by the board of trustees of the village to maintain a telephone exchange, has become the owner of the Citizens' telephone line and the franchise in Albion. Arrangements have been made to connect with the Interocean trunk line and the Lakeside line.

ATLANTIC, N. J.—Between $75,000 and $80,000 has been expended in improvements to the plant of the Atlantic Coast Telephone Company during the winter. A switchboard costing $40,000 is being installed in the company's new exchange, and it is expected that the system will be in operation very shortly. The local plant has a capacity of 4,000 instruments.

HUNTINGDON, TENN.—The Western Dixie Telephone Company has been organized at Vale with E. B. Simmons as president. The company has lines running from Camden to Huntingdon, as well as several branch lines giving connection with all places along and near the main line. It is the intention of the company to obtain a charter at an early date and do a general telephone business.

CLYDE, N. Y.—The farmers south of Clyde have organized a telephone company, Ward Lyron being the promoter of the enterprise. Sufficient funds have been raised to build the line from Clyde south to Waterloo, and the contract to construct the line has been given to the Wayne Telephone Company. About twenty farmers are interested in the venture and the line will be built as soon as the weather will permit.

HOT SPRINGS, S. D.—The W. G. Telephone Company has completed its line to this place and connected with the People's Telephone Company's exchange. The W. G. company has a line from a point about forty miles southeast of Buffalo Gap to Hot Springs. The Cheyenne Telephone Company has a line from a point about thirty-four miles east of Buffalo Gap, and at that place connects with the W. G. line, which gives it access to this place.

DETROIT, MICH.—A deed conveying all the property of the Michigan Telephone Company to the Michigan State Telephone Company as the assignee of N. W. Harris, the purchaser under foreclosure, has been filed with the register of deeds. There was filed at the same time a first mortgage executed by the Michigan State Telephone Company to the Old Colony Trust Company, of Boston, for $10,000,000 to secure an issue of a like amount of five per cent thirty-year gold bonds.

LOS ANGELES, CAL.—Directors of the Home Telephone Company have issued a statement to stockholders, showing the total number of telephones in operation March 15 to have been 11,747. There still are 5,000 applications on file, which are being taken up as rapidly as instruments can be installed. The financial statement is as follows: gross earnings for three months ending December 31, 1903, $67,633.71; operating expenses, insurance, taxes and maintenance of the plant, $21,949.10, leaving net earnings of $45,684.61. Interest on bonds was $23,325; available for dividends or increase of plant, $22,359.61.

ZANESVILLE, OHIO—The stockholders of the Adamsville Telephone Company at a meeting held recently elected the following board of directors: C. B. Bell, F. P. Winn, M. F. Tomlinson, C. H. Hanks and J. W. Elsea, of Adamsville, and S. M. Winn and J. B. Rhodes, of this city. The directors organized by electing as officers: president, J. B. Rhodes; vice-president, C. H. Hanks; secretary, F. P. Winn; treasurer, M. F. Tomlinson; manager, F. P. Winn; counsel, S. M. Winn. The stockholders made plans for the construction of an up-to-date exchange. The farmer lines will also be extended into the rural districts adjacent.

PLATTSBURG, N. Y.—At a meeting held at Troy the New Commercial Union Telephone Company was organized, to absorb the Rensselaer Telephone Company, of Troy; the Saratoga Telephone and Telegraph Company, of Saratoga, and the New Union Telephone Company, of Glens Falls. Officers and directors were elected as follows: president, John T. Christie, of Troy; secretary, W. N. Burk, of Glens Falls; treasurer, Peter McCarthy, of Troy; J. H. Caldwell, W. C. Greer, C. V. Collins, W. D. Mahoney, William Connors, of Troy; S. C. Medbury, Ballston; Edward Davis and W. D. Barnard, Philadelphia. It is the intention to at once extend the lines north to Plattsburg, east to North Adams and other Massachusetts cities, and west at an early date so that connection may be had as far west as St. Louis through agreements with the various companies.

ELECTRIC LIGHTING.

MINNEAPOLIS, MINN.—Having failed to reach an agreement with the Minneapolis General Electric Company, the Minneapolis Retailers' Association will establish a plant of its own.

TRINIDAD, COL.—The capacity of the electric light plant just completed here will be doubled within a few months, so that current can be supplied for working coal mines in Stonewall valley.

NEENAH, WIS.—The Wisconsin Traction, Heat, Light and Power Company, of which John I. Beggs, of Milwaukee, is the head, has secured ten-year franchises for lighting Neenah and Menasha. The two cities pay $5,000 apiece a year for lighting.

ANN ARBOR, MICH.—The common council has granted a franchise to the Michigan Milling Company for the erection of an electric light and power plant. The franchise was allowed on condition that all wires shall be placed under ground, over the space of one square mile in the city.

VICTOR, COL.—As a result of the announcement of a pooling combination on electric light rates in the Cripple Creek district between the local lighting companies, a number of merchants and property owners here have formed a company and will install an independent electric plant in this city.

LEWISTON, IDA.—Lewiston is to have a new electric light and power plant. The cost will be between $75,000 and $100,000. Surveys have been made and a deal is now pending for the purchase of a large tract of land in the eastern part of the city. A number of Spokane and Lewiston capitalists are interested in the project.

WATERBURY, CT.—Land for an extensive reservoir has been purchased and work will soon begin on an electric light plant for Woodbury and Pomperaug valley. The capital stock of the company is $15,000, and the promoters, Judge Warner and E. S. Boyd, are confident that the company will be prepared to install lights by early autumn of the present year.

TROY, N. Y.—The Hudson River Electric Company, which operates the immense dam at Spiers Falls, on the upper Hudson river, above Glens Falls, and is under contract to deliver all of its power, aside from the amount taken by the General Electric Company, to the United Traction Company and the Municipal Gas Company, of Albany, and the Troy Gas Company, has commenced the service. The amount transmitted to these companies is about 10,000 horsepower.

DUNKIRK, N. Y.—The annual report of the secretary of the water and lighting department has been submitted. This shows that during the year ending March 1, 1904, the total receipts aggregated $82,723.94, total disbursements, $74,232.09, leaving on hand $8,497.54. The operating expenses of the water department were $13,246.55. The average daily water pumped was 4,497,547 gallons. The arc system cost $8,956.04; commercial system, $5,929.89; income for operation of system, $7,113.16. The outstanding bonds figure to $180,100. Considerable water pipe was laid, both new mains and extensions.

OBITUARY NOTICES.

MR. HENRY A. BOGARDUS, a well-known telegraph operator, died recently in Chicago, Ill. Mr. Bogardus was born in Rochester, N. Y., sixty years ago. He had worked in nearly every telegraph office of importance in the United States, Canada and Mexico, and is said to have crossed the continent a number of times. The death of Mr. Bogardus, who was familiarly known as "Old Bogy," will be regretted by his many friends.

MR. CHESTER D. CRANDALL, manager of the Western Electric Company, Chicago, Ill., died on Tuesday, March 22, at his home in Chicago, Ill. Mr. Crandall was born in Jefferson County, N. Y., December 28, 1854. After leaving school he entered the University of Rochester, graduating in 1879. He became connected with the Western Electric Company in July, 1877, where he remained until August, 1881, when he was chosen secretary and treasurer of the Gilliland Electric Manufacturing Company, of Indianapolis. In March, 1889, he again entered the service of the Western Electric Company. Owing to his long illness he had not been active in business for more than a year. Mr. Crandall is survived by a widow and one daughter.

PERSONAL MENTION.

MR. W. E. GILMORE, of the Edison Manufacturing Company, Orange, N. J., sailed for Europe on Wednesday of this week.

MR. CHARLES E. LAWRENCE has been elected president of the Charlestown Water, Gas and Electric Company, Charlestown, Mass.

MR. WILLIAM L. SAUNDERS has been elected president of the Ingersoll-Sergeant Drill Company, succeeding the late Hon. William R. Grace.

MR. S. B. FORTENBAUGH, who is electrical engineer of the Underground Electric Railways Company, of London, is now in this country on a short visit.

MR. J. C. SMITH has been appointed assistant manager of the Postal Telegraph Company at Detroit, Mich. Mr. Smith was formerly manager of the Grand Rapids office of the company.

MR. CHARLES MONK, who was manager of the Central Union Telephone Company's exchange at Pontiac, Ill., has resigned to take charge of an independent telephone exchange at Fairbury, Ill.

MR. L. F. BOWER, secretary of the Allis-Chalmers Company, at Scranton, Pa., has been elected a director and secretary-treasurer of the Bullock Electric Manufacturing Company, Cincinnati, Ohio.

MR. HENRY JAMES, for many years connected with the Pencoyd Iron Works and also with the American Bridge Company, is now with the Philadelphia Roll and Machine Company, Philadelphia, Pa., as its roll designer.

MR. F. A. BROOKS, who for the past fifteen years has been manager of the Charleston Gas and Electric Company, Charleston, Ill., has resigned to engage in the electrical supply and contracting business in Charleston, Ill.

MR. CHARLES F. ANNETT, who was formerly assistant superintendent of telegraphs for the Illinois Central Railroad Company, has resigned to accept a position with the Shelby Electric Company as sales agent, with offices in Chicago, Ill.

MR. S. R. ROBINSON, who was connected with the Pittsburg & Allegheny Telephone Company, in its construction department, has resigned to accept a position with the Heeling & Ridge Company, Pittsburg, Pa., builder of telephones and other electrical apparatus.

MR. WALTER STEARNS, who was assistant superintendent of the Waltham Electric Light Company, Waltham, Mass., has accepted a position with the Fort Wayne Electric Works, Fort Wayne, Ind. Mr. Stearns is a graduate of the Massachusetts Institute of Technology.

MR. OLIVER D. COLVIN, who was manager of the American Steel and Wire Company's office at Seattle, Wash., has tendered his resignation. Mr. Colvin has been appointed manager of the Snoqualmie Falls & White River Power Company, which position he will occupy May 1.

MR. JOHN S. CRAVEN, of Pasadena, Cal., president of the American Conduit Company, is enjoying a pleasure trip to Europe for a year. Mr. A. W. Buchanan, general manager of the company, at present located at Los Angeles, Cal., will take charge of the Chicago office on May 1.

MR. WILLIAM VON PHUL, who has been associated with Sargent & Lundy, consulting engineers of Chicago, Ill., has accepted the position of general superintendent of the electric department of the Cincinnati Gas and Electric Company, to succeed Mr. J. Henry Hallberg, resigned.

MR. J. J. O'BRIEN, who for more than fourteen years has been in the auditing, accounting and financial departments of the Chicago office of the General Electric Company, and for the last few years having occupied the position of cashier and chief clerk of the Chicago office of that company, has resigned to take the position of general auditor with the engineering firm of H. M. Byllesby & Company, New York Life Building, Chicago, Ill.

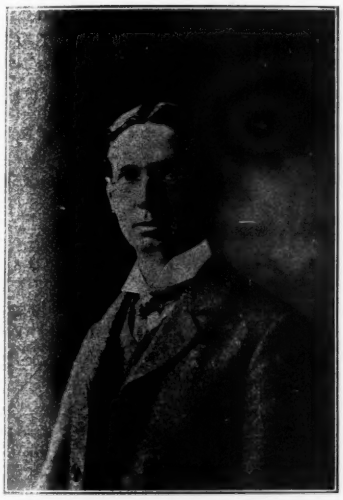
MR. C. C. STARR, who was formerly connected with the firm of John Starr & Company, has been engaged by the Canadian Westinghouse Company, Limited, Hamilton, Canada, to act as its representative in the Maritime Provinces, with headquarters at 134 Granville street, Halifax, Nova Scotia. The Maritime Provinces are included in the district of the Canadian Westinghouse Company's Montreal office, so that Mr. Starr will be an attache of that office.

MR. WALTER EDWARD DEVLIN was married to Miss Ethel Canon Munder, daughter of Mr. and Mrs. Charles Munder, of Phila-

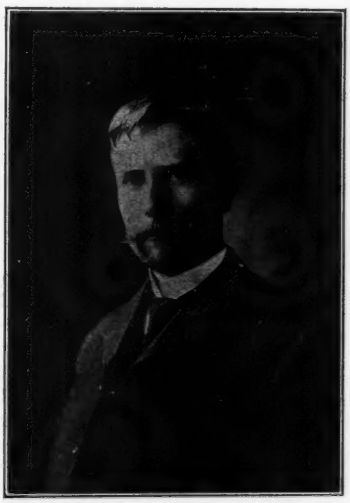
delphia, on April 4, at Saint Malachi's Church, Philadelphia. Mr. Devlin is president of the Malleable Iron Hardware Company, one of the large manufacturing concerns in Philadelphia, and which employs about 4,000 people. He is also president of the Brohard Company, which company is successor to the Cleverly electrical works.

MR. E. B. BUMSTED has been made general manager of the St. Lawrence River Power Company, in place of Mr. Edgar Park, who resigned this position quite recently. Mr. Bumsted will have headquarters in New York, the offices of the company being located in the Hanover Bank Building, at 11 Pine street. Mr. Bumsted went to Massena as draughtsman for T. A. Gillespie Company, during the progress of the work on the canal, and was soon promoted to a responsible position as engineer. At the conclusion of the work he was made engineer in charge by the power company, and later local manager and also general manager of the local electric light, water and telephone companies.

MR. SAMUEL G. McMEEN AND MR. KEMPSTER B. MILLER announce that they will open an office at 1442-3 Monadnock Block, Chicago, Ill., about April 25, 1904, as consulting engineers, solicitors of patents, and to practice individually as an expert in patent causes. Mr. McMeen for the last two years was an engineer with the Western Electric Company, in charge of telephone exchange equipments. Previously, for seventeen years, since leaving Purdue University, he was assistant engineer, chief engineer, and was located in various capacities in the operating, construction and engineering departments of the Central Union Telephone Company. Nine years of this time were spent in the company's headquarters in Chicago and eight years in the field, in Ohio, Indiana, Illinois and Iowa. Mr. McMeen's long and varied experience particularly fits him to meet the problems his new work will develop. He has lately completed a study of the telephone condition of the City of Mexico, preparing complete plans for extensive underground conduit and cable systems. Mr. Kempster B. Miller, Cornell, 1893, author of "American Telephone Practice," was with the Kellogg Switchboard and Supply Company for the past four years; with the International Correspondence School for one year, in which connection he prepared the text-books of that institution on the subjects of "Telephony" and "Telegraphy"; was chief electrician of the Western Telephone Construction Company; with the Westinghouse Electric and Manufacturing Company; in the United States Patent Office, three years in charge of the class of telephony in the electrical division; as draughtsman and inspector of drawings in the draughting room of the Thomson-Houston Electric Company, Lynn, Mass. Mr. Miller has served as expert in many important patent causes, and his ability in analysis of this sort is marked and well known.



MR. SAMUEL G. McMEEN



MR. KEMPSTER B. MILLER.

ELECTRICAL SECURITIES.

While the abnormal speculative dulness of the first week in March has not returned, there was considerable contraction in activity during the past week. It is expected that this return to an apathetic condition is indicative of the fact that there will be but little booming for some time. However, the general outlook is favorable to further advance, in that, while there has been a dropping in prices during the week, there is no tendency to severe reductions. It is reported that railroad earnings will show a considerable increase, and this is looked to to form the basis for material improvement. With the approach of the summer period, and the possibility of a crisis on May 1 in labor circles, there will probably be little done in the way of large contracting until after this time. It is quite possible, however, that there will be no decided break in the harmony which is existing at this time, and if this period is passed without trouble there will very likely be considerable animation in several directions in the industrial field.

ELECTRICAL SECURITIES FOR THE WEEK ENDING APRIL 2.

New York:	*Closing.*
Brooklyn Rapid Transit	44⅛
Consolidated Gas	197½
General Electric	164⅝
Kings County Electric	183
Manhattan Elevated	142½
Metropolitan Street Railway	111⅞
New York & New Jersey Telephone	142
Westinghouse Manufacturing Company	175

It is stated that earnings of the Brooklyn Rapid Transit Company are showing large and steady increases. Since July 1 the gross earnings of the system show more than $900,000 increase over the earnings of the corresponding nine months of last year. Since last fall the net revenue of the road has increased from 19 cents per car per mile to 26 cents per car per mile.

Boston:	*Closing.*
American Telephone and Telegraph	125½
Edison Electric Illuminating	234
Massachusetts Electric	73½
New England Telephone	120
Western Telephone and Telegraph preferred	80

At the annual meeting of the stockholders of the American Telephone and Telegraph Company the old board of directors was re-elected, Thomas B. Bailey taking the place of J. Malcolm Forbes, deceased.

The statement of the New England Telephone and Telegraph Company, as of December 31, 1903, shows total assets of $29,053,184 and liabilities of $27,578,577, leaving a surplus of $1,474,607.

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	56½
Electric Storage Battery preferred	56½
Philadelphia Electric	5½
Union Traction	49½
United Gas Improvement	82

The annual meeting of the Electric Company of America will be held on April 26.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	148
Metropolitan Elevated preferred	49
National Carbon common	28
National Carbon preferred	100
Union Traction common	5
Union Traction preferred	30

AUTOMOBILE NOTE.

THE AUTOMOBILE CLUB OF AMERICA, New York city, N. Y., is announcing the entries which have been received from companies wishing to participate in the service test of motor wagons. The companies entering electric vehicles are Lansden Motor Car Company, Cantono Electric Tractor Company, Pope Motor Car Company, Electric Vehicle Company and Fischer Motor-Vehicle Company, whose truck entered is a gasoline-electric vehicle.

INDUSTRIAL ITEMS.

THE RE-NEW LAMP COMPANY, 134 State street, Boston, Mass., has issued a circular treating on its "Malden" lamps. Circular will be sent on request.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, Ill., has recently brought out an interesting little catalogue treating on Leich four-party selective telephones. This catalogue will be sent on request.

HUGO REISINGER, 11 Broadway, New York city, has secured from the Louisiana Purchase Exposition Company, St. Louis, Mo., a contract for his "Electra highest grade Nuernberg carbons" for its entire requirements of carbons.

THE H. S. COUCH COMPANY, 156 Pearl street, Boston, Mass., has just brought out its illustrated price list "B," which shows many combinaticns in which its telephones can be used. This illustrated price list will be sent on request.

THE LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., manufacturer of many special designs of insulators for all kinds of electrical work, will increase the capacity of its plant from 50 to 100 per cent, to meet the growing demand for its product.

JAMES S. BARRON & COMPANY, West Broadway and Franklin street, New York city, N. Y., will send, upon request, samples of fibre cleats for telephone work. These are made in three colors. The company reports that it is meeting with a large demand for this material.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., is distributing a series of advertising blotters containing monthly calendars and a quotation from "Aleck," the electrician. Of course, in each case "P-K" is the remedy for anything out of order and the preventive of further trouble.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., has issued a very complete catalogue illustrating and describing the "Sederholm" boiler which it manufactures. This catalogue contains valuable information in connection with the requirements of a good boiler. Catalogue will be sent on request.

THE E. W. BLISS COMPANY, Brooklyn, N. Y., is distributing a handsome pamphlet entitled a treatise on "Power Presses." This describes the power presses and their uses with the Bliss company. The frontispiece of the booklet is a half-tone portrait of Mr. E. W. Bliss, the founder of the company.

THE NATIONAL INDIA-RUBBER COMPANY has removed its offices to the twelfth floor of 42 Broadway, New York city. The company will be represented as follows: rubber-insulated wires and cables, Henry D. Stanley; hose, belting and packing, Albert B. Pratt; druggists' sundries, Henry D. Archer.

G. M. GEST, the expert subway contractor of New York and Cincinnati, has just been awarded a contract by the Bell Telephone Company, of Cincinnati, Ohio, for the installation of a large conduit system through Cumminsville, one of the outlying districts of Cincinnati. Work is to be started immediately.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., describes in bulletin No. 3052, which it has just had published, alternating-current motors which it manufactures in sizes from one-twentieth to one-sixth horse-power, suited for any service for which motors of this type and capacity may be put. Bulletin will be sent on request.

THE PEABODY COAL COMPANY, Chicago, Ill., has prepared as a souvenir publication an article by Mr. A. Bement, on "The Economical Burning of Coal without Smoke, with Special Reference to the Use of Washed Coal." The book is divided into five chapters, treating, respectively, of heat efficiency, incomplete combustion, smoke and its prevention, washed coal and its preparation, and manipulation of fires and furnaces.

THE WESTON ELECTRICAL INSTRUMENT COMPANY has opened an office at 426 Williamson Building, Cleveland, Ohio, in charge of Mr. G. L. Crosby. Mr. Crosby will handle the "G-I" company's circuit-breakers and will cover a territory comprising western Pennsylvania, Ohio and Michigan. Mr. Crosby has covered this territory before in a similar capacity and is familiar with the instrument and circuit-breaker business of that territory.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburg, Pa., has published a handsome calendar for April, 1904, which it is sending out, together with a leaflet containing a reprint of a letter received from the Fairbury Electric Light, Heat and Power Company, a statement concerning "Pittsburgh" transformers, and a statement in which the company announces that it is prepared to repair burned-out transformers of the core-type construction. Leaflet and calendar will be sent on request.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has just issued a handsome forty-eight-page catalogue containing brief descriptions, with illustrations, of all the lines of apparatus which the company manufactures, from the great 3,500-kilowatt alternators to the small 250-volt knife-blade switch. The catalogue is from the office of Ray D. Lillibridge, and the text exhibits throughout that lucidity and conciseness of expression which characterize all the work of R. H. Johnston, technical writer in that office.

THE COUCH & SEELEY COMPANY, Boston, Mass., has prepared a new catalogue descriptive of its telephone switchboards and telephone accessories. This company's apparatus is in use in over 3,000 independent exchanges, private plants, government buildings, railroad plants and industrial establishments. The catalogue gives an accurate description and prices of the company's apparatus, and the half-tones show very clearly the appearance of the devices. An interesting supplement to the commercial details of the catalogue is a series of plans showing the manner in which circuit connections are made.

THE ELECTRIC GAS LIGHTING COMPANY, 195 Devonshire street, Boston, Mass., is distributing a new catalogue descriptive of Edison primary batteries. These batteries are for stationary and portable gas engines, slot machines, fan motors, railroad signals, phonographs, sewing-machines, X-ray outfits, electromedical use, telephone, fire and burglar-alarm systems, and all classes of work where a primary battery may be used. The catalogue illustrates the many types in which this cell is made, and also gives directions for making the jar liquid type and for charging. This company is also the sales agent for a special Edison spark coil for gas engine work.

THE INDIA-RUBBER AND GUTTA-PERCHA INSULATING COMPANY, Yonkers, N. Y., has prepared a unique illustrated catalogue concerning its manufacture of Habirshaw wires and cables. This catalogue has been compiled by Mr. Frederick J. Hall. The text is comprehensive and accurate, and instead of depending upon half-tone reproductions for illustration, photographic prints have been mounted throughout the book, showing in detail the section of various types of the Habirshaw cables. This is one of the most interesting publications which has ever been produced by a manufacturing company, and will do a great deal in bringing to the contractor a perfect knowledge of the mechanical and electrical features of this material.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., successor to the Christensen Engineering Company, has inaugurated a new department at its plant. This is in the form of a complete kitchen equipment for the officers and employés of the executive offices. Two pleasant dining rooms, a butler's pantry and a kitchen have been fitted up in the new office building recently erected at the company's plant near Riverside Park. The dining rooms and kitchen are located on the second floor of the building. One dining room is for the officers of the company and their guests, and business men from other cities who go to Milwaukee to inspect the plant. It is expected that the officers will get into closer personal touch with each other by dining together at noon, and that many informal executive sessions for the discussion of the company's interest will be had. The second dining room will be for the employés of the offices and the engineering department. There will be no charge whatever to the employés for the dinners, but the company's object is not purely philanthropic, as it is believed that the plan will be mutually beneficial to employer and employed. The company expects to be more than repaid for the expenditure in the increased interest with which its employés will regard their work, and the time that will be saved in eliminating the necessity of a lengthy recess for luncheon.